Environmental and Permitting Assessment

South Fork Wind Farm and South Fork Export Cable

March 9, 2018

Prepared for:

Deepwater Wind South Fork, LLC

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1.0 INTRODUCTION

This document has been prepared to support ongoing discussions between Deepwater Wind South Fork, LLC (DWSF) and both the Town of East Hampton and the East Hampton Town Trustees. This Environmental and Permitting Assessment provides a synopsis of the siting, environmental, and permitting considerations for the South Fork Wind Farm (SFWF) and the offshore portions of the South Fork Export Cable (SFEC) as well as the onshore portion of the SFEC, based on a sea-to-shore transition located at Beach Lane in Wainscott, East Hampton, New York. Siting and environmental assessment at the SFWF and SFEC is ongoing; therefore, the data and information presented in this report are current through the date of report submission. Information is subject to change and may be updated based on new data and findings prior to permit application submittal. We undertake no obligation to update or supplement this report after the date hereof.

2.0 PROJECT OVERVIEW

2.1 BACKGROUND

DWSF and Long Island Power Authority (LIPA) are parties to a Power Purchase Agreement (PPA). The PPA resulted from a technology-neutral competitive bidding process initiated by LIPA to identify the most cost-effective option for addressing a power supply need in the South Fork of Suffolk County, Long Island. DWSF is developing the SFWF and SFEC to generate electricity from an offshore wind farm located in the Bureau of Ocean Energy Management (BOEM) Renewable Energy Lease Area OCS-A-0486 off the coasts of Rhode Island and Massachusetts (Appendix A, Figure 1) and transmit it to the East Hampton substation located off Cove Hollow Road in East Hampton, New York, based on a sea-to-shore transition located at Beach Lane (Appendix A, Figures 2-5).[1]

Significant stakeholder and scientific review was conducted as part of the siting process for the SFWF. The BOEM Lease Area OCS-A-0486 is located in an area initially identified as an “Area of Mutual Interest” (AMI) by the governors of Rhode Island and Massachusetts in 2010. During the following few years, BOEM conducted a stakeholder and scientific review process to refine the boundaries of the wind energy area, particularly regarding the location of shipping lanes, commercial and recreational fishing areas, viewsheds of coastal areas, as well as other natural resources and physical conditions. As described in BOEM’s Environmental Assessment completed in 2013, BOEM refined the location of the AMI into the Rhode Island – Massachusetts Wind Energy Area (WEA) based on the results of this research and discussion and removed areas of “high value” fisheries. In 2013, BOEM awarded Renewable Energy Lease Area OCS-A-0486 to Deepwater Wind following a competitive bidding process.[2]

The general operational concept for the SFWF is that the energy in the wind turns the wind turbine generator (WTG or turbine) blades to generate electricity. Electricity generated from each WTG is collected through a series of inter-array cables that terminate at an offshore substation platform. The offshore substation connects to an export cable

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[1] This Environmental and Permitting Assessment is limited to the landing site at Beach Lane. DWSF is also considering landing sites at Hither Hills State Park and Napeague State Park, which are not discussed in this document.
[2] The environmental assessment and the lease are both available at www.boem.gov/Renewable-Energy-Program/State-Activities/RI/Executed-Lease-OCS-A-0486.aspx.

that carries the power to an onshore substation. The onshore substation interconnects with an existing substation where clean, renewable power will be transmitted to the electrical grid.

The SFWF and SFEC enable LIPA to defer or avoid building additional fossil-fired power generation and transmission upgrades in the South Fork of Long Island. Additionally, the SFWF represents the first step in achieving New York State's goal of becoming a national leader in offshore wind, and it supports the State of New York's Clean Energy Standard to meet 50 percent of New York's electricity needs with renewable sources by 2030. Further, it supports goals set by the Towns of East Hampton and Southampton to transition to 100 percent renewable energy.[3]

The onshore portion of the SFEC in East Hampton will be located underground within public road right-of-ways and alongside the tracks within the Long Island Railroad (LIRR) right-of-way. The only aboveground infrastructure associated with the SFEC will be the addition of a new onshore substation located adjacent to the existing East Hampton substation within the existing parcel owned by National Grid. The SFEC will not cause an undesirable change in the character of the surrounding neighborhood or alter the essential character of the surrounding neighborhood. In addition, it will not create detriment to nearby properties and will not cause permanent or significant adverse impact on the physical or environmental conditions in East Hampton.

2.2 PROJECT FACILITIES

This section provides a description of the SFWF and SFEC components and proposed locations. Activities associated with construction and installation, commissioning, operations and maintenance, and conceptual decommissioning are discussed in Section 2.3.

SFWF includes up to 15 WTGs, inter-array cables, and an offshore substation, all of which will be located in federal waters approximately 19 miles southeast of Block Island, Rhode Island, and approximately 35 miles east of Montauk Point, New York.

The SFEC is a submarine and terrestrial electrical cable that will connect SFWF to the existing mainland electrical grid. The SFEC includes the following components, based on a sea-to-shore transition at Beach Lane:

- SFEC – OCS: the segment of the export cable within federal waters on the Outer Continental Shelf (OCS) from the offshore substation to the boundary of New York State (NYS) territorial waters (approximately 58 miles);
- SFEC – NYS: the segment of the export cable from the boundary of NYS waters to a sea-to-shore transition located in the Town of East Hampton at Beach Lane in the hamlet of Wainscott (approximately 3 miles); and
- SFEC – Onshore: the segment of the export cable from the sea-to-shore transition to a new onshore substation where the SFEC will interconnect with the LIPA system in the Town of East Hampton (approximately 4 miles).

[3] The East Hampton Town Board adopted Resolution 2014-662 on May 20, 2014, and the Southampton Town Board adopted resolution 2017-475 on May 9, 2017. Each board unanimously adopted their respective resolution.

Other ancillary facilities include:

- SFEC – Onshore Substation: A new substation located adjacent to, and within the same parcel as LIPA's existing East Hampton Substation on Cove Hollow Road.

- SFWF – Operations and Maintenance Facility (O&M Facility): will be located on an existing parcel in Montauk within the Town of East Hampton, or Quonset Point in the Town of North Kingstown, Rhode Island. DWSF has committed to locating a SFWF – O&M Facility in Montauk if its request for real estate rights for a cable landing at Beach Lane in Wainscott are granted.

Appendix A includes figures referenced in this report. The approximate location of the SFWF and the SFEC is shown in Figure 1. The preferred route for the SFEC – Onshore is shown in Figure 2 as Beach Lane – Route A. The sea-to-shore transition at Beach Lane is depicted in Figures 3-5, including an aerial photo, a conceptual drawing, and a cross-section. The alternative routes that DWSF is considering for SFEC – Onshore are shown in Figure 6. Existing land uses along the SFEC – Onshore are shown in Figure 7, wetlands along the SFEC – Onshore Beach Lane route are depicted in Figure 8, and mapped floodplains are shown in Figure 9.

2.2.1 SFWF

The SFWF will consist of 15 WTGs that will be located at least .8 miles apart. The WTG model that will be deployed will be selected by DWSF based on suitability for the SFWF and what is commercially available to support the Project schedule. Each turbine will be supported by a foundation installed into the seafloor. DWSF will select the foundation type that is best suited for the SFWF area based on site-specific physical data collected during site characterization surveys and detailed engineering and design. Three foundation types are under consideration for the SFWF:

- Jacket: one steel lattice structure per WTG secured to the sea floor by four steel piles embedded into the sea floor;
- Monopile: one steel monopile per WTG embedded into the sea floor; or
- Gravity Base Structure (GBS): one pre-cast concrete, ballasted base per WTG shallowly penetrated into the sea floor.

The inter-array cable will connect the individual WTGs and transfer power between the WTGs and the offshore substation. The inter-array cable is expected to be a 34.5 kilovolt (kV) 3-phase alternating-current (AC) cable. The cable contains three conductors, screens, insulators, fillers, sheathing, and armor, as well as fiber optic cables. The inter-array cable does not contain lubricants, liquids, or oils. The inter-array cable will be buried to a target depth of 4 to 6 feet beneath the seafloor. The inter-array cable will require extra protection or armoring (e.g., rock or engineered concrete mattresses) adjacent to the foundation where the cable emerges from the trench to connect with the foundation.

The offshore substation will collect electric energy supplied by the WTGs through the inter-array cables and condition this energy for transmission through the SFEC to the onshore substation. The offshore substation will be above the water and located either on a platform supported by a foundation similar to those used for the WTGs or co-located on a foundation with a WTG. The offshore substation will consist of a high voltage power transformer, reactor, and switchgear together with secondary medium voltage transformers, switchgear, and utility equipment. The offshore substation will also house the Supervisory Control and Data Acquisition (SCADA) system that serves as the means for monitoring and control between the WTG, substation, and an onshore operation center(s).

2.2.2 SFEC – OCS and SFEC – NYS

The submarine cable for the SFEC – OCS and SFEC – NYS will comprise one segment of single three-core conductor and two fiber optic cables for communication and control. The SFEC will carry 3-phase 138 kilovolt (kV) high voltage alternating current (HVAC) and will operate as a bi-directional conduit for power flow.

The SFEC will be up to 12 inches in diameter, including a continuous three-conductor and fiber optic bundle that will be encased in a water sealed jacket, which is wrapped in either a single or double-steel armor wire. The bundle will be wrapped in a polyester yarn, which is likely to exhibit bright black and yellow striping for identification and handling.

The SFEC will be buried to a target depth of 4 to 6 feet in the seafloor along the entire route of the cable. If target burial depth cannot be achieved for some portions of the SFEC (e.g., cable crossings) extra protection or armoring, such as engineered concrete mattresses, will be used.

2.2.3 SFEC – Sea-to-Shore Transition

The sea-to-shore transition connects the SFEC – NYS to the SFEC – Onshore. The offshore and onshore cables will be spliced together so the cable can be routed to the onshore substation by an underground electrical duct bank. The sea-to-shore transition will include a new onshore underground transition vault within Beach Lane set back in the roadway approximately 500 feet from the end of the Beach Lane pavement (Appendix A, Figure 3-4). The cable will be installed via horizontal directional drilling (HDD) under the beach and the intertidal zone. If necessary, a temporary cofferdam may be installed at least 2,000 feet offshore. The cable conduit will be installed beneath the visible beach at least 30 feet below its current profile, and at least 10 feet below the buried glacial headlands (Appendix A, Figure 5). This installation depth will protect the cable conduit from the effects of erosion, even in the most severe weather events.

2.2.4 SFEC – Onshore

The SFEC – Onshore will be installed within a new underground duct bank. The SFEC-Onshore cables comprise three single core cables with a conductor of either copper or aluminum and two separate fiber optic cables, which will provide communication and control. Duct banks will be designed to accommodate up to two circuits. The SFEC – Onshore will carry 3-phase 138 kilovolt (kV) HVAC power and will operate as a bi-directional conduit for power flow.

Each conductor will be approximately 2 to 4 inches in diameter, including a single-core cable, with compact round, uncoated copper wires. The cable will be insulated with cross-linked polyethylene (XLPE) and would be sheathed by a semi-conductive insulation screen and wrapped in a high-density polypropylene (HDPE) jacket. Electric cables can generate electromagnetic fields (EMF). The electric field for the SFEC – Onshore is contained within the body of each cable by the cable sheathing so no changes to electric field levels are expected. Magnetic field levels for the SFEC – Onshore at a height of one meter above ground are expected to be below the limit set by NYSPSC of 200 mG at the edge of the right-of-way.

The duct bank will be located underground within public road right-of-ways and alongside the tracks within the LIRR right-of-way. The SFEC – Onshore will not include any overhead lines before arriving in the SFEC – Onshore Substation.

The existing land uses along the majority of the SFEC – Onshore are predominantly low-medium residential (all single-family residences), industrial, open space, and vacant land (undeveloped land not reserved as a community preservation area or a nature preservation area). To a lesser extent, surrounding uses also includes commercial, utility/transportation, institutional/community facilities, and recreational uses (Appendix A, Figure 7).

2.2.5 SFEC – Onshore Substation

The SFEC – Onshore Substation will be located in East Hampton's Commercial Industrial (CI) zoning district, on the same parcel that contains LIPA's existing East Hampton substation. The site for SFEC – Onshore Substation is bounded to the east by the existing substation/diesel and gas facility as well as a planned battery storage facility. To the north is the LIRR, as well as existing transmission lines and a storage unit facility. West and south of the substation site are suburban residential neighborhoods and a scenic easement buffer that provides 100 feet to 150 feet of protected natural landscape. Other nearby land uses include additional residential neighborhoods, commercial and industrial uses, and forest (Appendix A, Figure 7).

The configuration of the SFEC – Onshore Substation and the interconnection to the East Hampton substation will be developed as part of the New York Independent System Operator (NYISO) interconnection process and will include the equipment necessary to safely connect the SFEC with the New York transmission grid system.

2.3 PROJECT ACTIVITIES

2.3.1 Offshore Installation

Offshore installation of the Project is scheduled to take place over a two-year period and completed in the following general sequence:

Year One

- Mobilization of vessels and transportation of materials;
- Transportation of the foundations to the wind farm site;
- Installation of the foundations;

Year Two

- Installation of the cable systems; and,
- Installation of the WTGs and offshore substation.

Installation activities will be scheduled in accordance with environmental time of year restrictions and seasonal work windows.

The general process for installation of the SFWF involves the installation of the foundations to the sea floor and preparation of the structures for the WTGs. Work vessels then supply and assemble all the WTG parts and install them on the foundations. Depending on the type of foundation selected (Section 2.2.1), pile driving may be utilized to install the foundations.

Installation of the SFEC will be conducted during Year 2 of the construction period, in coordination with installation of the SFWF. The submarine portion of the SFEC will be buried under the seafloor as a means to protect the cable from damage caused by external forces and to minimize conflict with other marine uses. The burial method is dependent on seabed conditions and sediments along the cable route. Therefore, in areas where seabed conditions might not allow for cable burial (e.g., cable crossings), other methods of cable protection may be employed, such as articulated concrete mattresses or rock placement.

The preferred method of cable installation involves using a simultaneous trench and lay process in which a self-propelled mechanical trenching plow creates a trench along the seafloor and the cable is simultaneously laid and buried in a single pass. This process is similar to the methods utilized for Block Island Wind Farm (BIWF) installation, which was studied closely by BOEM. That study confirmed that sediment plumes were not observed during installation and that the disturbed area filled back as the sediment settled naturally.[4]

2.3.2 Sea-to-Shore Transition Installation

The SFEC-NYS will transition from sea-to-shore via a conduit installed under the beach using a construction method known as horizontal directional drilling (HDD). HDD is a common technology for drilling underground along a prescribed path and is used frequently to avoid impacts to sensitive environmental areas like shorelines, wetlands and rivers/streams. Use of the HDD for the sea-to-shore transition avoids disturbance to the inter-tidal zone, the beach and dunes.

In Wainscott, the workspace for the HDD and drill entry point will be located approximately 500 feet north of the end of Beach Lane within the public road right-of-way. The HDD (as well as the conduit and cable) will end at least 2,000 feet offshore and will be installed under the visible beach at least 30 feet below its current profile and at least 10 feet below the buried glacial headlands (Appendix A, Figures 3-5).

Before drilling begins, a temporary cofferdam may be installed offshore at the end point of the HDD. The cofferdam may be installed as either sheet piled structure into the sea floor or a gravity cell structure placed on the sea floor using ballast weight. Installation of the cofferdam and drilling support will be conducted from an offshore work barge anchored in the vicinity of the cofferdam. Any sediment that may need to be removed from within the cofferdam will be sidecast next to the cofferdam area and left to naturally disperse. The dimensions of the cofferdam structure will depend on which type is used but typically are less than 75 feet by 25 feet.

A bentonite-water-based mud or another non-toxic drilling fluid will typically be used to cool the drill bit, maintain borehole stability, and control fluid loss during boring operations. Drilling mud will be injected into the drill pipe onshore via pumps that are located within the HDD workspace. The mud will be jetted through a rotating drill bit attached at the end of the drill pipe. Jetting of the mud will cool the drill bit and suspend drill cuttings within the mud solution. Mud and cuttings will flow back to the surface in the gap between the drill pipe and bore hole coating the bore hole, wall which prevents the mud from leaking into the ground. Once the mud flows back to the bore hole entry point, it will be collected and reused.

The conduit will consist of a thick-wall high-density polyethylene (HDPE) pipe with a maximum diameter of 24 inches within which the submarine cable will be installed. The HDD equipment will be used to pull the HDPE pipe through the drill hole to create a stable conduit for bringing the cable ashore. After installation of the HDPE conduit, a transition vault will be installed in the roadway in the area of the drill pit. A pull line will be placed inside the finished conduit to facilitate pulling the SFEC through the conduit. After the SFEC is pulled through the conduit, the submarine

[4] Observing Cable Laying and Particle Settlement During the Construction of the Block Island Wind Farm. OCS Study 2017-027. https://www.boem.gov/ESPIS/5/5596.pdf

and fiber optic cables will be spliced to the SFEC-Onshore cable within the transition vault. The transition vault will be sealed, covered, and repaved within the roadway with a manhole cover at the surface.

Pedestrian and vehicle access to the Beach Lane beach will be maintained throughout installation. Upon completion of installation, the only visible element of the SFEC at the sea-to-shore transition will be the manholes within the existing road. DWSF has agreed to a time-of-year restriction for the HDD with all drilling activities completed between November 1 and March 31. The only activity that is currently scheduled to occur after March 31 is the final pull of the cable through the conduit and subsequent splicing, which is expected to take approximately 11 days. The final pull of the cable is similar to routine electric utility work or repairs, with one or two utility bucket trucks and personnel working in the manhole.

2.3.3 Onshore Installation

The SFEC – Onshore will be located underground within public road right-of-ways, and alongside the tracks within the LIRR right-of-way. The only aboveground component will be SFEC – Onshore Substation.

The installation for SFEC – Onshore is expected to include the following activities:

- Site preparation and excavation for underground duct bank;
- Cable installation in underground duct bank; and
- HDD, where appropriate, for crossing existing infrastructure (e.g., NYS Route 27).

The installation for the SFEC – Onshore Substation is expected to include the following activities:

- Site preparation, excavation, and grading;
- Construction of foundations for the control building, transformer, reactors, and switchgear;
- Construction of electrical grounding, duct banks, and underground conduits;
- Installation of appropriate drainage systems and station service including electrical and water; and
- Installation of all above ground structures including transformer, switchgear, and cable systems, as well as insulating and noise mitigation walls and screening.

2.3.4 Operations & Maintenance

DWSF will be responsible for the operation of the SFWF and SFEC.

The SFWF and SFEC will be monitored 24 hours a day, 365 days a year from an onshore operations center. Issues that cannot be fixed remotely will be addressed on-site by trained technicians. The SFEC is not expected to require planned maintenance; however, inspections and tests will be conducted regularly based on a manufacturer-recommended schedule, and any repairs will be based on manufacturer-suggested methods.

Prior to the commencement of operations, a permit and environmental compliance plan will be prepared that will outline specific operating obligations and summarize regulatory and permit requirements in a user-friendly format. Components of the permit and environmental compliance plan are likely to include materials such as a summary of any required agency notifications, project-specific training materials, field guides for identification of rare and threatened species, and a list of time-of-year restrictions.

3.0 REGULATORY FRAMEWORK AND SCHEDULE

3.1 PERMITS AND CONSULTATIONS

The SFWF and SFEC-OCS are proposed in federal waters on the OCS. The SFEC-NYS and SFEC-Onshore are proposed in waters of the State of New York, and onshore in the State of New York, respectively. Multiple federal and state governmental authorities have regulatory authority over components of the SFEC (Appendix B). The BOEM is expected to be the lead federal agency during the review of the project under the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*) for environmental effects and benefits. The U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA) will act as cooperating agencies. Consulting agencies for the NEPA review will include, at a minimum, National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), United States Coast Guard (USCG), and United Stated Fish and Wildlife Service (USFWS). The New York Public Service Commission (NYSPSC) will lead the review of the SFEC-NYS and SFEC-Onshore in the State of New York under Article VII of The New York Public Service Law, which will include review under Section 401 of the Clean Water Act (CWA).

The SFWF and SFEC will require a Construction and Operations Plan (COP) that is compliant with BOEM regulations (30 CFR 585) and approved by BOEM prior to the commencement of construction. The SFWF and SFEC will also require various other federal approvals including an Individual Permit from the USACE under Section 10 of the Rivers and Harbors Act (33 USC 403) and Section 404 of the CWA (33 USC 1344) and an Outer Continental Shelf Air Permit from EPA in accordance with the Clean Air Act 42 USC 7627 40 CFR Part 55, 60.

The SFWF and/or SFEC are also required to comply with a variety of other federal regulations. Consultation and review will occur with NMFS under the Magnuson-Stevens Fisheries Conservation and Management Act and the Marine Mammal Protection Act; USFWS and NMFS under Section 7 of the Endangered Species Act (ESA); National Park Service (NPS) for the Abandoned Shipwreck Act; U.S. Coast Guard; U.S. Department of Defense; and with the Bureau of Safety and Environmental Enforcement (BSEE). In addition, federal agency review of the projects must comply with Section 106 of the National Historic Preservation Act (NHPA), and Section 307 of the Coastal Zone Management Act (CZMA).

In addition, prior to the start of construction, DWSF must obtain a State Pollutant Discharge Elimination System General Permit (SPDES) for Stormwater Discharges from Construction Activity from NYS Department of Environmental Conservation (NYSDEC), a Utility Work Permit from NYS Department of Transportation, and a Grant to use NYS Lands Under Water from NYS Office of General Services, Bureau of Land Management.

Consultation and review will also occur with NYSDEC for state-listed threatened and endangered species and unique or significant habitats; NYS Office of Parks, Recreation and Historic Preservation and the State Office of Historic Preservation for cultural and historic resources; and NYS Department of Agriculture and Markets for agricultural lands.

3.2 COMPLIANCE WITH LOCAL REGULATIONS

Public Service Law (PSL) 130 precludes a municipality from requiring any approval, consent, permit or certificate that would be applicable to a transmission facility subject to Article VII of the PSL. Accordingly, DWSF will not be seeking a road opening permit, building permit, site plan approval, architectural review board approval, natural resources special permit, waterfront revitalization program consistency review, or zoning review from any affected municipality because any such requirements are pre-empted by PSL 130.

DWSF plans to comply with the substantive aspects of these local review processes. For example, for the SFEC – Onshore Substation, clearing will be consistent with as-of-right building allowances under local zoning (Commercial Industrial) and screening will be sensitive to aesthetics. Installation activities for both SFEC – Onshore and SFEC – Onshore Substation will be consistent with relevant local standards for noise and light.

3.3 SUMMARY OF ASSESSMENTS TO SUPPORT PERMITTING

As part of the permitting process, a wide variety of assessments are currently in-progress, including field surveys, both offshore and onshore, as well as desktop analysis and modeling.

Offshore Field Surveys

- Marine Archeological Surveys
- Geophysical and Geotechnical Surveys
- Avian and Bat Surveys
- Benthic Surveys
- Fish and Fisheries Surveys

Onshore Field Surveys

- Archaeological and Cultural Resource Surveys
- Land and Topographic Surveys
- Wetland Delineation
- Sensitive Habitat and Specie Surveys
- Ecological Habitat Characterization
- Visual Impact Assessment

Desktop Assessment and Modeling

- Electric Magnetic Field Modeling
- Essential Fish Habitat Analysis
- Navigational Risk Assessment
- Air Emissions Analysis
- Underwater and In-Air Noise Modeling
- Marine Mammal Risk Assessment
- Sediment Transport Modeling
- Visual Impact Assessment
- Socioeconomic Assessment

3.4 OVERALL PROJECT SCHEDULE

The project is on schedule to be operational by 2022. Key milestones include:

- 2010 to operations — Outreach to communities and stakeholders
- Q1 2018 — Major permit application submissions
- 2018 to 2020 — Agency review, science and engineering assessment
- Q1 2020 — Major permits issued
- Q1 2021 — Offshore installation starts
- Q4 2022 — Completion of installation and start of operations

4.0 STAKEHOLDER AND AGENCY OUTREACH

DWSF has engaged in extensive outreach with federal and state agencies, municipalities, federally recognized Native American tribes, stakeholders representing various interest groups, and the public since 2010. Since 2016, DWSF has met and/or consulted with the following stakeholders:

Federal Agencies

- US Army Corp of Engineers (USACE)
- Bureau of Ocean Energy Management (BOEM)
- Bureau of Safety and Environmental Enforcement (BSEE)
- National Marine Fisheries Service (NMFS)
- National Ocean and Atmospheric Administration (NOAA)
- US Environmental Protection Agency (USEPA)
- US Fish and Wildlife Service (USFWS)
- US Coast Guard (USCG)
- US National Park Service (NPS)
- US Department of Defense (DOD)

State Agencies

- NYS Public Service Commission (NYSPSC)
- NYS Department of Public Service (NYSDPS)
- NYS Department of State (NYSDOS)
- NYS Parks, Recreation and Historic Preservation (OPRHP)
- NYS Department of Environmental Conservation (NYSDEC)
- NYS State Historic Preservation Office (NYS SHPO)
- RI Coastal Resources Management Council (RI CRMC)
- RI Department of Environmental Management (RI DEM)
- MA Coastal Zone Management Office (MA CZM)
- MA Department of Environmental Protection (MA DEP)
- CT Department of Energy and Environmental Protection (CT DEEP)

Other Stakeholders

- Town of East Hampton
- Village of East Hampton
- Trustees of East Hampton
- Tribes, including the Shinnecock Indian Nation and other federally-recognized tribes in New England
- Fishing Community (Ports of Montauk, Shinnecock, and other ports elsewhere in New England, as well as a variety of recreational and commercial fishing groups)
- Local Organizations/Community Groups (East Hampton Historical Society, Wainscott Citizens Advisory Committee (CAC), Amagansett CAC, East Hampton Rotary Club)
- Academic and Scientific Organizations (SUNY Stonybrook, Cornell Cooperative Extension)
- Non-Governmental Organizations (New York Audubon Society, The Nature Conservancy, Surfrider Foundation, Perfect Earth Project, Citizens Campaign for the Environment, Concerned Citizens of Montauk, Group for the East End, Defend H2O, Perfect Earth Project)

5.0 PRELIMINARY RESOURCE ASSESSMENTS

A significant amount of information regarding a wide variety of environmental resources will be provided to regulatory agencies throughout the permitting and environmental impact assessment process. This section includes a brief description of the environmental resources offshore, at the sea-to-shore transition, and onshore; an overview of assessments completed or in-progress by firms who are part of the environmental and permitting team for DWSF; and a preliminary summary of potential effects and mitigation measures. In addition, a memo from Exponent regarding the potential effects to marine life from EMF and from HDD is included in Appendix C. As development of the Project progresses, DWSF will continue discussions with the agencies and stakeholders listed in Section 4 to refine potential impacts and discuss mitigation measures.

5.1 HABITAT AND GEOLOGICAL ASSESSMENTS

5.1.1 Benthic Habitat

Offshore

Benthic habitats found along the SFEC and at the SFWF area greatly range in composition. Habitats include macroalgal assemblages, hard bottom habitat, microbenthic and macrobenthic communities, soft bottom habitat, and shellfish resources. DWSF has reviewed available historic data sets to characterize and assess the benthic habitat. These studies included sediment grain size analysis, seafloor habitat characterization, and mobile invertebrate fisheries sampling. These data sets were collected by organizations such as the NMFS, the United States Geological Service (USGS), various academic institutions, and state and municipal agencies in New York. DWSF conducted a geophysical and geotechnical survey in 2017, which included a benthic habitat assessment. Sediment core samples and photo imagery of the seafloor were collected at the SFWF and along the entire SFEC route. Results of this survey will be included in the COP when it is submitted to BOEM.

The sediments are generally composed of mostly sandy sediments with some areas of coarser material (gravel or small cobble) and boulder fields, with the potential for larger pockets of hard bottom habitats to be present in or near the SFWF. No submerged aquatic vegetation (i.e., eelgrass) has been identified in the vicinity of the SFWF nor would it be expected due to depth limitations and the high hydrodynamic activity along Long Island's southern coastline. Benthic macroalgae is only expected to be present in low densities at the SFWF and along the SFEC-OCS and associated with hard bottom habitats.

The sediment grain sizes observed include medium grain sand, gravel/granule, and cobble/boulder. In sandy habitat (e.g., closer to southern shore of Long Island where SFEC-NYS will be located), the dominant species are expected to be tube-dwelling and predatory polychaete worms; blood stars; sand dollars; bivalve mollusks including sea scallop, ocean quahog, and Atlantic surf clam; gastropods including moon snails and channeled whelk; amphipods; and arthropods including hermit crabs and Atlantic rock crabs. In the gravel/granule and cobble/boulder habitat like that found in the SFWF and eastern portions of the SFEC-OCS, slower growing sessile invertebrates such as hydrozoans, anemones, tunicates, and encrusting sponges are expected to be present, as well as tube forming and mobile polychaete worms. Other invertebrates expected to occur in hard bottom seafloor habitats include blood stars, sea stars, sea scallop, brittle stars, arthropods including hermit crabs, Jonah Crab, Atlantic rock crab, American lobster, and nudibranchs.

The SFWF and SFEC-OCS contains habitat suitable for economically and ecologically important invertebrate species such as Atlantic sea scallop, Jonah crab, Atlantic rock crab, channeled whelk, ocean quahog clam, Atlantic surf clam, and horseshoe crab. Northern shortfin squid are expected to occur in the vicinity of SFWF, and longfin squid are expected to be seasonally present. Habitat for American lobster is expected to be low quality, but the species may transit the area and occur in low densities.

Installation and operations activities associated with the SFWF and SFEC have the potential to cause seafloor disturbance, sediment suspension, and deposition.

Localized seafloor disturbance, resulting in temporary increases in sediment suspension and subsequent deposition, will occur during certain installation activities including: seafloor preparation, pile driving (if necessary) and foundation installation, installation of the submarine cable, and vessel anchoring. Increased sediment deposition may result in impacts to benthic organisms through smothering, particularly for sessile benthic organisms and any demersal egg and larvae stages. Mobile benthic organisms are expected to move out of the way of incoming sediments and larger sessile organisms may be able to extend feeding tubes and respiratory structures above the sediment. Seafloor disturbance and sediment suspension may also result in impacts to macroalgae habitat which may be present on hard surfaces. Seafloor disturbance and sediment suspension and deposition are not expected to result in major or long-term effects to benthic organisms. Based on studies conducted at Block Island Wind, benthic species are expected to recolonize the impacted area following construction activities.

5.1.2 Coastal Geology

Sea-to-Shore Transition

The characteristics of the coastal geology at the sea-to-shore transition site at Beach Lane influences the depth to which the SFEC will be buried. The coastal characteristics in this area are very dynamic. Eighty years of geological measurements have documented a hard bottom. Data from 1939 to 2017 shows that although the dune has diminished in height from over 30 feet in 1939 to less than 20 feet in 2017, horizontal changes have occurred from both erosion and accretion and the shoreline experiences periods of recovery between each erosional event.

The beach profile indicates that subsurface headland soils (pre-Holocene glacial till or outwash) intersects with recently deposited beach/dune sands that overlie the headland soils. The recent Holocene (post glacial) soils are a thin overlay cover of the headland (glacial) soils. Shoreline changes during storms have periodically revealed the location of these headland soils and in the nearshore zone. The headland and beach/dune interface lies at the seaward edge of pavement. The headland soils at this location are resistant to coastal erosion because they are semi-consolidated till and/or glacial outwash soils.

First Coastal Corporation conducted an analysis for DWSF of the available beach profile data (Appendix D) that provides insight into historical changes to the beach and dunes. First Coastal Corporation also conducted an evaluation for DWSF of potential shoreline impacts, including a review of impacts documented by the USGS following Superstorm Sandy in 2012, as well as coastal erosion from other large storm events (Appendix D).

Changes in shoreline, particularly coastal erosion hazards that result from storms, have been considered during project planning, particularly to establish the appropriate burial depth for the cable. As described in Appendix D, in the area immediately adjacent to Beach Lane, Superstorm Sandy resulted in dune collision with minor impacts to the dune structure. Overwash occurred at Beach Lane due to low to no dune in the road right-of-way. Impacts from other large storms were modeled to be less than or similar to the specific results of Superstorm Sandy; however, DWSF understands that stronger storms could also impact the area. The cable conduit will be installed beneath the visible beach at least 30 feet below its current profile and at least 10 feet below the buried glacial headlands (Appendix A, Figure 4-5). At this depth, the cable conduit will be protected from erosion, even in the most severe weather events.

5.1.3 Coastal Habitat and Wetlands

Sea-to-Shore Transition

DWSF engaged Vanasse Hangen Brustlin, Inc. (VHB), based in Happauge, New York, to conduct desktop research, agency consultations, and field surveys of ecological resources at the sea-to-shore transition site and along the SFEC-Onshore. Field surveys were conducted between May and November 2017 and included classification of observed habitats, delineations of freshwater and tidal wetlands, identifications of plant and wildlife species, observations of rare/protected species and communities, and delineation of invasive species occurrences.

At the sea-to-shore transition site at Beach Lane, the beach exhibits a typical pattern of topography, including a berm and beach face, as well as dunes along neighboring properties. The beach has both a winter profile and summer profile. Like other sandy shore beaches on Long Island, the specific characteristics of the coastal habitats at this site are constantly changing because of wave action and tidal currents that cause sediment transport. In New York, the littoral zone along any coast line is considered a tidal wetland. The littoral zone is the area between of the high tide mark and the point of permanent inundation, below the low-tide mark. The littoral zone at the sea-to-shore transition site has been documented as a tidal wetland (Appendix A, Figure 8); this wetland is classified by NYSDEC within the littoral zone and characterized by the National Wetland Inventory (NWI) as M1UBL (marine, subtidal, unconsolidated bottom, subtidal).

Direct effects to coastal habitats and tidal wetlands, including any impacts to the littoral zone, will be avoided at the sea-to-shore transition by the use of HDD between the drill pit sited inland within an existing road and the cofferdam located offshore.

Onshore

The SFEC-Onshore will be located under surface roadways and within the LIRR right-of-ways, which are generally characterized primarily by unvegetated, impervious roadways or railroad beds and the adjacent vegetated and unvegetated cover types. Many of the areas adjacent to the onshore corridor exhibit varying degrees of disturbance, due to vehicular/pedestrian traffic, road/railroad maintenance practices, or disturbance due to adjoining residential and commercial development. Very limited portions of the SFEC will be located in existing roads that intersect with a FEMA-mapped 100-year floodplain (Appendix A, Figure 9). Because the SFEC will be located underground, it will not affect existing infrastructure in these areas.

The SFEC-Onshore has been sited to avoid all direct wetland impacts. Along a small portion of Beach Lane Route-B (Appendix A, Figure 8), near the crossing of Montauk Highway, one tidal wetland area (upper reaches of Georgica Pond) was mapped in the vicinity of the route; this area is not adjacent to the route and only the associated wetland buffer zone intersects with the route in the existing roadway. In the same area of Beach Lane Route-B, near the crossing of Montauk Highway to Hedges Lane, freshwater wetlands were documented; however, they are not adjacent to the route and only the associated wetland buffer zone intersects with the existing roadway. Along Beach Lane Route A, no wetlands have been documented.

Routine operation of the SFEC is not expected to impact any coastal or wetland habitats. If cable repair is needed, effects would be limited to short-term and localized disturbance similar to typical work completed in manholes along public roads throughout East Hampton.

5.2 WILDLIFE ASSESSMENTS

5.2.1 Threatened and Endangered Species

As part of both the federal and state permitting process, potential impacts to threatened and endangered species are evaluated. Several listed species have been identified, based on review of information from USFWS, NMFS, and NYNHP.

Based on review of information from NMFS, six federally-threatened (T) or federally-endangered (E) species may occur offshore, including one fish and five marine mammals: are Atlantic sturgeon (E), blue whale (E), fin whale (E), North Atlantic right whale (E), sei whale (E), and sperm whale (E).

Based on review of information from USFWS, six federally-threatened or federally-endangered species may occur in the vicinity of the SFWF, SFEC-OCS, SFEC-NYS or along the route for SFEC-Onshore, including three birds, one mammal, and two plants. The federally-listed species are: piping plover (T), red knot (T), roseate tern (E), northern long-eared bat (T), sandplain gerardia (E), and seabeach amaranth (T).

Based on review of information from NYNHP, three state-threatened or state-endangered species may occur along the route for SFEC-Onshore, including two bird species and one plant. The state-listed species are: piping plover (E), least tern (T), and orange fringed orchid (E).

As described in Section 5.1.3, DWSF conducted comprehensive natural resource surveys along the route for the SFEC–Onshore. The locations of rare/protected species and associated species habitats observed during the field surveys were documented. Neither the butterfly species nor any of the plant species were documented. As described in Section 5.2.4, nesting locations for piping plover and least tern were documented near the sea-to-shore transition; however, HDD will occur between November through March, months when beach-dwelling birds and shorebirds are not likely to be present.

Section 5.2.2 provides additional discussion about listed fish species, Section 5.2.3 provides additional discussion about listed marine mammal species, and Section 5.2.4 includes a discussion of the potential impacts to birds and bats.

5.2.2 Fisheries

Offshore

A wide variety of marine and estuarine fish species are known to occur in the vicinity of the SFWF and SFEC. The fish species potentially present can be categorized into two groups based on the portion of the water column that they occupy: demersal (bottom dweller) fish and pelagic (surface or water column dweller) fish. There are approximately 66 fish species of economic or ecological importance present within the region of the SFWF, including 29 demersal fish and 37 pelagic fish. Year-round demersal fish near SFWF on the continental shelf include Atlantic cod, Atlantic halibut, cunner, sand lance, sea raven, silver hake (juveniles and adults), and yellowtail flounder. Year-round pelagic fish include American plaice, silver hake (eggs and larvae), and whiting. Species likely to be present along the SFEC-NYS in more coastal waters include (but are not limited to) striped bass, bluefish, scup, Atlantic menhaden, winter and summer flounder, black sea bass, blackfish, weakfish, sea robins, false albacore, monkfish, winter skate, and smooth dogfish. The EMF report in Appendix C includes additional information about species that could be present along the SFEC-NYS and discussion of the potential EMF impacts.

One federally listed endangered species, the Atlantic sturgeon, may occur. When in marine waters, Atlantic sturgeon are primarily found in shallow coastal waters, though they may utilize deeper shelf waters for overwintering. However, the SFWF is not a known overwintering area. Atlantic sturgeon may be present in or near the SFEC during spring or fall migration periods but is less likely to be present during summer or winter. Telemetry data suggests that the western section of the SFEC closer to Long Island is most heavily used for migration. As an anadromous species, adults return to natal river systems for spawning, though not all individuals spawn every year.

Regional baseline abundance fisheries survey data are available and based on studies funded by BOEM and NMFS, as well as the states of Massachusetts, Rhode Island, and New York. These surveys are conducted to evaluate the presence and movement patterns of various marine fish species. DWSF has contracted with INSPIRE to collected information about offshore habitats that are known to support fish species throughout various life stages. Within the area surrounding the SFWF, INSPIRE is conducting a rod and reel survey to investigate the potential for presence of spawning cod. INSPIRE also conducted trawl and lobster surveys before, during, and after construction at BIWF, the results of which inform the assessments for SFWF and SFEC.

Finfish may be affected by impacts such as seafloor disturbance or alteration of habitat and increased noise. Modification or disturbance of the substrate is not expected to negatively impact pelagic species, if present, since these species are not dependent on benthic habitat. There may be some adverse impacts to the habitat of demersal/benthic species resulting from construction, but these are expected to be minor, localized, and largely temporary. After construction, except for limited areas where soft substrate will be converted to hard substrate due to foundation installation or concrete mattress installation, the substrates would remain fundamentally the same as pre-construction conditions and allow for the continued use by finfish species. Benthic organisms are expected to recolonize the areas disturbed during installation allowing for continued foraging habitat for finfish species. The acreage range of benthic habitat that is expected to be affected by construction is small relative to the total area of available surrounding habitat. DWSF will attempt to site turbines to avoid sensitive habitats known to support important fish assemblages. To mitigate potential impacts, DWSF will employ installation techniques and equipment, e.g., jet-plow and HDD, that are known to substantially minimize disturbance and alteration of substrate and, therefore, limiting impacts on fish species.

If installation includes pile driving for foundations, the associated noise has the potential to affect fish species in the surrounding area. Potential direct effects may include changes in fish behavior, temporary avoidance of an area, increased risk of predation, interruption of migratory patterns, interruption of communication, and potential injury. Less mobile species would be expected to be more susceptible to pile driving noise than more mobile species as they would not be able to leave the area as quickly. Atlantic sturgeon have been shown to avoid pile-driving activities in the Hudson River and, based on this, are not expected to be exposed to the cumulative sound exposure limit. Effects associated with noise are expected to be short-term with finfish returning to the area after the noise-generating activity has been completed. Noise mitigation measures will be evaluated for use during pile driving.

5.2.3 Marine Mammals and Sea Turtles

Offshore

There are 39 species of marine mammals that are known to inhabit the Western North Atlantic OCS, including 6 Mysticetes (baleen whales), 28 Odontocetes (toothed whales, dolphins, and porpoise), 4 Phocids (earless or true seals), and 1 species of Sirenia (manatees). All 39 species are protected under the Marine Mammal Protection Act and 5 whale species are also protected under the ESA—blue whale, fin whale, North Atlantic right whale, sei whale, and sperm whale—all of which are endangered.

The non-ESA listed marine mammal species that are known to occur within or proximal to the SFWF and SFEC include the humpback whale, minke whale, Atlantic spotted dolphin, Atlantic white-sided dolphin, pygmy sperm whale, common bottlenose dolphin, long-finned pilot whale, Risso's dolphin, short-beaked common dolphin, striped dolphin, white beaked dolphin, harbor porpoise, gray seal, harbor seal, harp seal, and hooded seal.

Four sea turtle species, green sea turtle, Kemp's Ridley, leatherback sea turtle, and loggerhead sea turtle are commonly found throughout the continental shelf and slope waters of the northwest Atlantic Ocean. All four species are listed as endangered or threatened. A fifth species, hawksbill sea turtle, may potentially occur within the region; however, this species is more commonly found in tropical waters and coral reef habitats.

Significant information has been collected about the presence and movement patterns of marine mammals and sea turtles in the vicinity of SFWF and SFEC, and this information is being incorporated into specific evaluations as part of the permitting process. DWSF contracted Jasco Engineering and Sales, Inc. (JASCO) to perform underwater acoustic modeling assessment for both SFWF and SFEC, which will result in a strong understanding of the likely decibel levels associated with various construction activities.

Installation activities, resulting in noise and increased vessel traffic, are expected to result in temporary impacts to marine mammals and sea turtles. Noise generated from pile driving (if necessary) and vessel traffic can affect the behavior and physiology of marine mammals, including avoidance of the source of sound, disruption of feeding behaviors, or interruption and modification of vocal activity. The results of the underwater acoustic modeling that is being completed by JASCO will be used to evaluate the projected sound pressure levels generated from pile driving and compared to hearing thresholds to evaluate impacts to marine mammals and sea turtles.

Temporary vessel traffic during construction increases the risk of ship strikes, which can result in injury or death of marine mammals and sea turtles. Variables that contribute to the likelihood of a collision include vessel speed, vessel size and type, and visibility. Large work vessels will generally transit to the work location and remain in the area until installation is complete. These large vessels will move slowly and over short distances between work locations, decreasing the risk to marine mammals and sea turtles.

The following Best Management Practices will be implemented to minimize impacts on marine mammals and sea turtles: strike avoidance measures; vessel speed restrictions; establishment of monitoring and exclusion zones and the use of protected species observers to monitor those established zones; ramp-up, soft-start, and shut-down procedures; and time-of-day restrictions. DWSF will also continue to consult with BOEM and NOAA to establish and implement appropriate mitigation measures.

5.2.4 Avian and Bat Species

Offshore

Several recent studies have been conducted to evaluate the presence and distribution of birds and bats in the vicinity of the SFWF and SFEC. These studies included bird observation inventories compiled by BOEM and by the states of New York, Massachusetts, and Rhode Island, each of which provide information on presence, seasonality, migration patterns, nesting, and habitat utilization. Inventories of bat observation data were collected by BOEM and the U.S. Department of Energy. Stantec has conducted acoustic bird and bat detector surveys as part of SFWF geotechnical and geophysical surveys. In addition, Stantec is also conducting monitoring surveys at BIWF to characterize bird and bat activity near the operational turbines and these surveys will inform SFWF.

Generally, bird abundance and the number of species decreases from nearshore to offshore environments. Birds likely to occur in the vicinity of the SFWF and SFEC include marine and coastal birds such as loons, gannets, storm-petrels, shearwaters, sea ducks, terns, and alcids. Typically, these birds will occur as solitary individuals moving through the area, though the presence of schools of prey may concentrate species such as shearwaters, petrels, and terns for relatively short periods of time. Shorebirds such as plovers, sandpipers, and phalaropes, and seaducks also could occur during migration, though far less frequently than marine birds. In studies of the BIWF, the most abundant species were herring gull, great black-backed gull, black scoter, surf scoter, white-winged scoter, common eider, alcid species, common loon, red-throated loon, and northern gannet.

Several bat species have been documented offshore, mainly during spring, summer, and fall migration periods. Bats are also known to use manmade structures on island and offshore locations for roosting, including lighthouses and offshore wind turbines.

Three state and federally-listed bird species that may occur in or near the SFWF or SFEC are the roseate tern (federally and state endangered), piping plover (federally-threatened, state-endangered), and red knot (federally-threatened). Based on biological assessments conducted by BOEM and subsequent consultations with USFWS, the likelihood of roseate terns occurring near SFWF has been determined to be "extremely low". Recent telemetry studies suggest that piping plovers and red knots typically remain close to shore during migration, but sometimes occur offshore. They could occur proximal to the SFWF in spring or fall, though likely infrequently.

Avian species may experience temporary displacement or disturbance due to offshore construction activities that result in increased vessel traffic, noise, temporary work lighting, and increased turbidity. The arrival of construction vessels could temporarily displace loafing or foraging birds. Since this type of disturbance already occurs to some extent due to existing levels of vessel activity, the temporary increase in activity and associated disturbance is likely to have only a minor effect on birds in the area. If installation includes pile driving for foundations, the associated noise has the potential to temporarily displace marine and coastal birds from offshore feeding areas and staging and resting areas. These impacts will be short in duration and limited in scale, and displaced individuals are expected to return to the area after construction. Because bats forage primarily in the airspace (as opposed to the water's surface), they are not likely to be impacted by noise related to pile-driving and vessel traffic.

Species that forage in coastal areas, such as terns, may be affected by the increased turbidity caused by suspended sediments during installation of the coastal portions of the submarine cable; however, disturbance of the sediment would likely persist for only a few hours depending on the sediment type and location.

Lighting on wind turbines may disrupt nocturnal bird (i.e., passerines and shorebirds) and bat migration, particularly during inclement weather. Under good weather conditions, most migratory bird species fly at altitudes hundreds of feet above mean sea level; however, some individuals may fly lower. The migratory flight heights of birds differ among taxonomic groups and are often associated with the height of favorable winds at the time of migration. There is also potential for mortality of bird and bat species due to collisions with wind turbines. Although little information is available on avian and bat fatality rates at operational offshore wind facilities, DWSF is actively studying these issues at BIWF and results of these assessments will inform operations at SFWF.

Sea-to-Shore Transition

Inventories of birds, mammals, and herpetofauna (amphibians and reptiles) observed or expected to occur were compiled through desktop review of previous surveys in the project area, including annual piping plover reports, as well as consultation with state and federal agencies and observations of species and habitat conditions during field surveys.

Two state-listed bird species have been documented to nest in the vicinity of the sea-to-shore transition site: piping plover (state endangered and federally threatened) and least tern (state threatened).

The corridor for the sea-to-shore transition will occur underground approximately 100 meters (~325 feet) south of a known piping plover nesting area, which may also contain nests of least tern (state threatened). Other species of shorebirds that may breed on or near this area include American oystercatcher, killdeer, and willet. Multiple shorebird species such as red knot (federally threatened), sanderling, dunlin, and purple sandpiper, may use the intertidal areas for feeding. Terns and related species forage over shallow waters and sandspits near shore. Common terns, roseate terns (state and federally endangered), and back skimmer (state special concern species), may breed in the vicinity of the SFEC on adjacent coastal habitats. Other state-protected bird species that could be present in the vicinity include glossy ibis, little blue heron, snowy egret, tri-colored heron.

In general, birds nesting proximal to installation activities that involve noise, lighting, or increased human presence could have reduced reproductive success due to disruption of nest activities, i.e., incubation, chick rearing, or abandonment of nest sites by adults. Birds feeding or resting proximal to such activities may be disturbed, which could lead to indirect effects such as reduced fitness and ultimately survival during migration.

At the sea-to-shore transition, the cable will be installed under the beach via HDD, from an entrance point within the roadway to an exit point offshore beyond the intertidal zone; therefore, some birds nesting, foraging, or resting on the beach or in the intertidal zone may be affected by noise and vibration of the HDD and may be temporarily displaced from the area during installation. However, that disruption will be short-term and localized, and no long-term impacts are expected.

Use of an HDD for the sea-to-shore transition mitigates the majority of potential impacts. Additionally, DWSF has agreed to limit the HDD work window from November through March, months when beach-dwelling birds and shorebirds are not likely to be present.

Onshore

Based on desktop review, agency consultation, and field surveys, multiple passerine species likely nest in vegetated areas proximal to the SFEC – Onshore and tree- and foliage-roosting migratory bat species may also be present during the summer roosting period.

Installation of SFEC – Onshore will primarily utilize a corridor that consists of existing road or LIRR right-of-ways that are adjacent to residential and some commercial areas. Species that are sensitive to disturbances from human activity may be temporarily displaced. However, since this type of disturbance already occurs to some extent within and adjacent to the SFEC – Onshore due to existing levels of vehicle activity, the temporary increase of activity and associated disturbances is likely to have only a minor, short-term effect on birds in the area. Tree clearing activities at the SFEC – Onshore Substation will occur outside the summer roosting period; therefore, disturbance to bat species is not expected.

Routine operation of SFEC – Onshore is not expected to impact birds or bats. If cable repair is needed, effects would be limited to potential short-term and localized disturbance.

5.3 OTHER ASSESSMENTS

5.3.1 Cultural Resource Assessment

Offshore

Cultural resources include sites, buildings, structures, objects, and districts that illustrate important aspects of prehistory or history or that have important and long-standing cultural associations with established communities or social groups.

DWSF has contracted Gray and Pape to conduct investigations to identify and evaluate cultural resources that may be affected by project construction, operations, or decommissioning as part of our planning and permitting process. DWSF has also met with agency and tribal representatives (Shinnecock Indian Nation and federally recognized tribes in New England) and conducted oral interviews and is conducting both desktop and field studies.

The offshore environments along Long Island and southeastern New England have been the subject of numerous scientific studies. Desktop studies have included intensive and on-going review to develop a detailed geological and paleoenvironmental context for potential cultural resources. The field studies include marine archaeological analysis of data collected during geophysical and geotechnical surveys to local potentially significant cultural resources that may be impacted by project activities. These resources include submerged archaeological sites, geological features with pre-contact period archaeological sensitivity, and remote sensing anomalies or targets that may be associated with post-contact cultural resources, such as shipwrecks.

DWSF has sited the SFWF and SFEC based on results of marine archaeological studies as well as input from agencies and tribal representatives during project development. Consistent with BOEM guidelines and regulations, DWSF anticipates avoidance of submerged cultural resources that may be identified during the field studies. Determination of cultural resource significance and treatment are important steps in the federal review and permitting process and will be completed by BOEM in consultation with multiple parties prior to any agency approval for construction of the project. Even under the best of circumstances, no survey can fully eliminate the potential for discovery of cultural resources during project construction. Therefore, DWSF is developing protocols that will specify stop work, notification, and consultation procedures in the event of unanticipated discoveries during construction.

Onshore

Cultural resources include archaeological sites, aboveground buildings and structures, objects, districts, traditional cultural properties, and other properties that illustrate important aspects of prehistory or history or that have important and long-standing cultural associations with established communities or social groups.

DWSF has contracted with The Public Archaeology Laboratory (PAL) and Environmental Design and Research (EDR) to conduct investigations to identify and evaluate cultural resources that may be affected by project construction, operations, or decommissioning as part of our planning and permitting process.

DWSF has met with agency and tribal representatives (Shinnecock Indian Nation and federally recognized tribes in New England) and conducted oral interviews and is conducting both desktop and field studies.

DWSF has sited the SFEC-Onshore within previously disturbed areas and has considered the results of both terrestrial archaeological studies as well as input from agencies and tribal representatives during project development. Based on the results of surveys at the sea-to-shore transition site, DWSF does not anticipate impacts to cultural resources along the shoreline. Several consulting tribes have identified potential for archaeological resources that may be present beneath the roadways along the SFEC-Onshore route. DWSF has completed supplemental desktop research to evaluate the archaeological sensitivity of the roadways and plans to undertake limited subsurface testing of select road margins in the 2018. Even under the best of circumstances, no survey can fully eliminate the potential for post-review discovery of cultural resources. Therefore, DWSF is developing protocols that will specify stop work, notification, and consultation procedures in the event of unanticipated discoveries during construction.

5.3.2 Visual Assessment

Offshore

Turbines for SFWF will be installed approximately 35 miles east of Montauk Point. The ability for an observer to see turbines is dependent on several factors, including presence of onshore topography, vegetation, and structures at the viewing location, as well as weather conditions, curvature of the earth’s surface, and atmospheric refraction.

Due to the curvature of the earth's surface, objects on the horizon are not seen in their entirety because they are partially hidden by the visible horizon; as the distance from the viewing location to the object increases, the visible portion of the object decreases. In addition, visibility is further reduced by atmospheric retraction; refraction of light in the earth's atmosphere curves our line of sight downwards, particularly at long distances.

DWSF contracted Environmental Design and Research (EDR) to complete a Visual Impact Assessment (VIA) for the turbines, which includes developing a visual resource inventory; describing the typical use, visual character, key observation points, and typical user groups; conducting a viewshed analysis and field verification; completing visual simulations which are reviewed by an independent panel of visual assessment professionals (landscape architects and planners). Based on findings from the VIA, the closest viewpoint to SFWF in New York is from Montauk Point, which also has the most open and unobstructed view towards SFWF. At Montauk Point, the SFWF will be nearly indistinguishable on the horizon resulting in no change in the views at this viewpoint. Additionally, the aviation lighting which will be used at night will not be visible from Montauk Point due to the screening effect from the curvature of the earth.

Onshore

SFEC – Onshore will be installed underground and, therefore, will not result in visual impacts. The SFEC – Onshore Substation and manholes in the road will be the only visible aboveground project infrastructure in East Hampton.

EDR is also conducting a VIA for the SFEC – Onshore Substation, which includes mapping any known archaeologic, geologic, historical or scenic area, park or untouched wilderness within three miles; describing the land use, visual character, visually sensitive resources, and typical user groups; conducting a viewshed analysis and field verification; and completing visual simulations. As described in Section 2.2.5, the SFEC – Onshore Substation will be located on a portion of the parcel where the existing East Hampton Substation is located; this use is consistent with the allowable uses for this property under local zoning (Commercial Industrial).

Based on preliminary findings from the VIA, the SFEC – Onshore Substation may be visible from less than two percent of the three-mile study area, and this visibility may be further limited due to densely situated buildings and houses and dense, mature forest in the surrounding areas. Existing vegetation screens the majority of views from nearby vantage points in publicly accessible right-of-ways. Additionally, DWSF is developing a visual mitigation plan that will include fencing and vegetation to further screen the SFEC – Onshore Substation.

5.3.3 Noise Assessment

Offshore

Noise associated with project activities will be assessed as part of both the federal and state permitting process. Noise impacts are generally expected to fit into two categories: temporary impacts resulting from installation activities and long-term impacts resulting from operation. High-intensity noises, resulting primarily from installation activities (e.g., equipment used to install turbines and cables, vessel traffic), are of greater concern because of the potential impact to receptors (e.g., fish, wildlife, humans). Impacts on receptors vary ranging from nuisance and annoyance through interference with activities or physiological effects. Noise impacts greatly depend on the distances between the sound-producing activities and the receptors, as well as the characteristics of the sounds (e.g., intensity, frequency, duration, and sound propagation or loss).

Noise during installation can be characterized as impulsive (e.g., pile driving for turbine foundation installation) or continuous, (e.g., thrusters of dynamically positioned (DP) vessels for the cable lay). JASCO is performing acoustic modeling for DWSF of the underwater noise from both sources to generate predictions of the sound propagation area and ranges to acoustic thresholds that may result in injury to or behavioral disruption of cetaceans and sea turtles (see Section 5.2.3). CH2M is performing modeling for DWSF of in-air noise levels and propagation from pile driving.

Onshore

As part of both the federal and state permitting process, impacts from noise must be evaluated. Recognition or perception of sound as noise, however, is very subjective and circumstantial based on the receptor's experience as well as the different properties of sounds. Noise impacts are generally expected to fit into two categories: temporary impacts resulting from construction equipment and long-term impacts resulting from operation. High-intensity noises, resulting primarily from construction activities (e.g., equipment used for HDD), are of greater concern because of the potential impact to wildlife and human receptors. Impacts on receptors vary ranging from subjective effects (e.g., nuisance and annoyance) through interference with activities or physiological effects. Noise impacts greatly depend on the distances between the sound-producing activities and the receptors, as well as the characteristics of the sounds (e.g., intensity, frequency, duration, and sound propagation or loss).

VHB is conducting an assessment for DWSF of the expected noise impacts associated with HDD construction activities as well as with operations of the SFEC – Onshore Substation. Both HDD construction and operational noise associated with the SFEC – Onshore Substation will comply with relevant noise standards for the Town of East Hampton (§ 185-3).

5.3.4 Navigational Risk Assessment

Offshore

As part of the federal permitting process, DWSF is conducting a navigational safety risk assessment and is coordinating with the USCG to review the findings of that assessment and to manage and mitigate risks that may be identified.

The navigational risk assessment describes issues that could affect navigation, including maritime traffic and vessel characteristics; navigational considerations; collision, allusion, and grounding assessment; communications, radar, and positioning assessment; and other considerations relevant to USCG mission.

The SFWF and SFEC will be clearly marked on applicable NOAA nautical charts. Due to the large distance between WTGs, they are not anticipated to significantly increase risk to vessels operating within the boundaries of SFWF. To mitigate any potential risk, DWSF will install AIS transponders on the corners of SFWF and provide frequent notices to mariners regarding project activities.

Appendix A FIGURES

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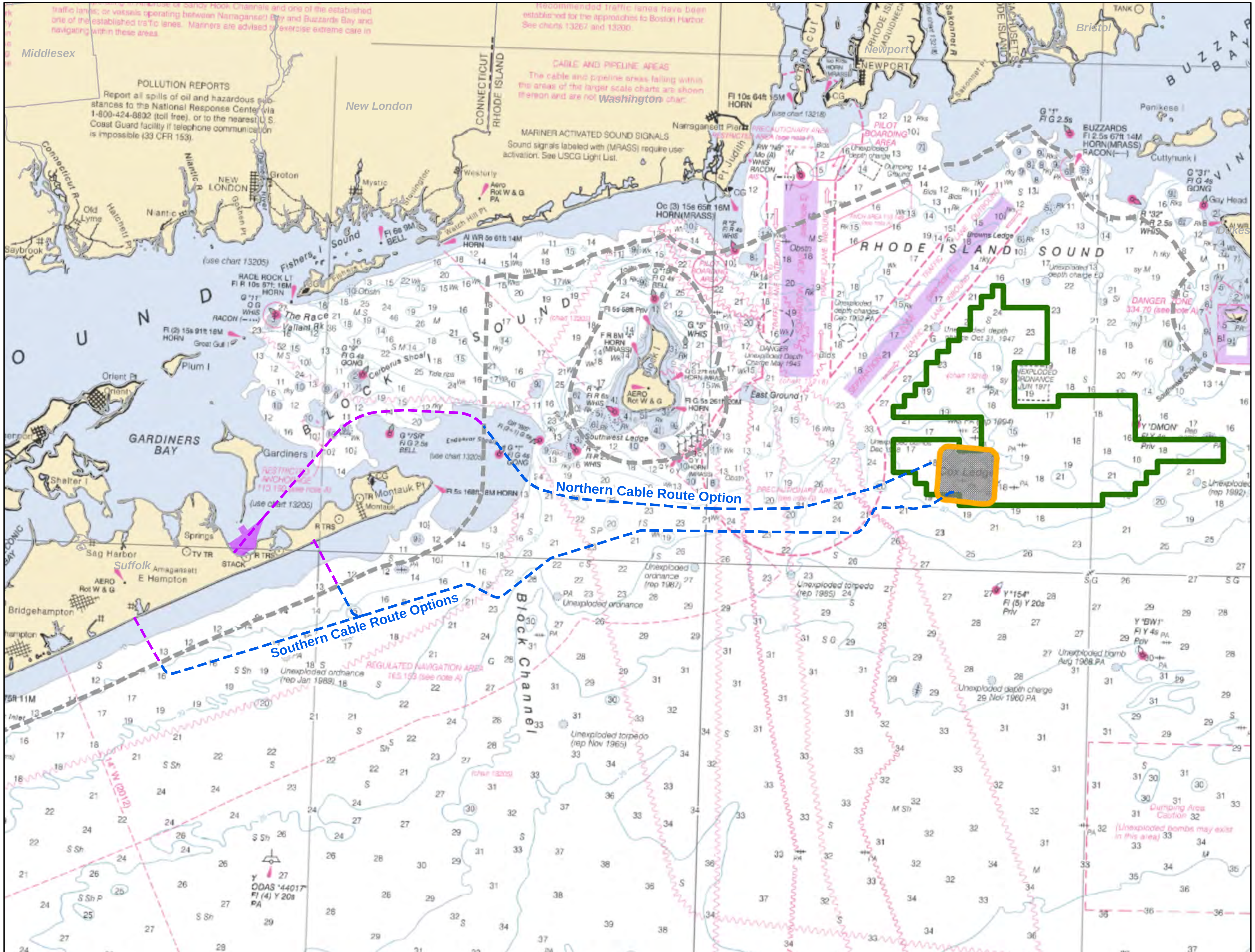
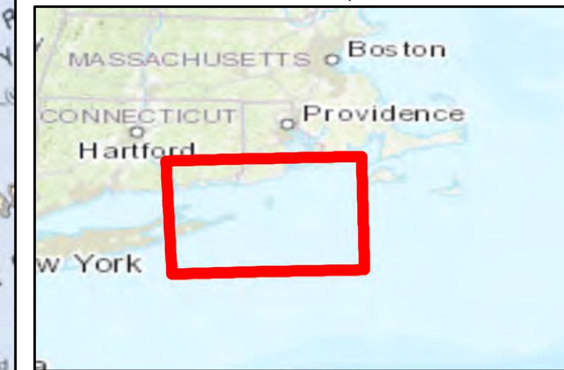
Figure 1



Locator Map



Legend

- Lease Area OCS-A0486
- 3-Nautical Mile State Waters Boundary

South Fork Wind Farm (SFWF)

- Maximum Work Area

South Fork Export Cable (SFEC):

- SFEC Federal Waters (OCS)
- SFEC New York State Waters (NYS)

Source:
NOAA Nautical Char tile service.
Note:
Soundings in fathoms at mean low water.

N

0 7 14
Miles

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Kilometers

SOUTH FORK WINDFARM

South Fork Wind Farm
Deepwater Wind
New York/Rhode Island, US
2/26/2018

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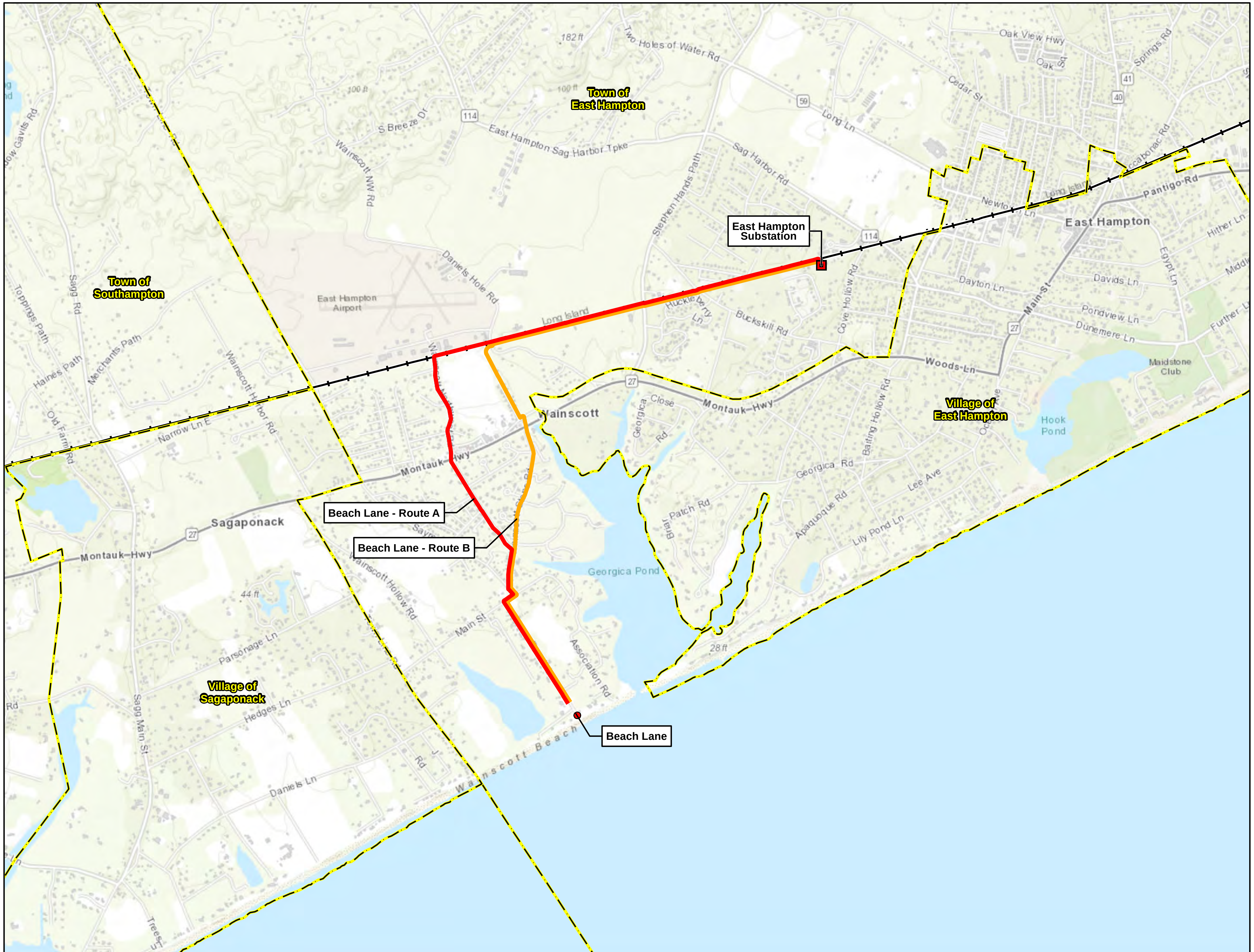
Figure 2



Locator Map

Legend

Substation:
- East Hampton Substation

Landing Site:
- Beach Lane

SFEC - Onshore Routes:
- Beach Lane - Route A
- Beach Lane - Route B
- Railroad
- Municipal Boundary

Disclaimer:
Draft for discussion purposes. Data may change.

Sources:
1. ESRI World Topo; 2. Civil Boundaries, NYS ITS GIS Program Office, 2017

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SOUTH FORK WINDFARM

Beach Lane Alternative Routes Overview
February 22, 2018
Deepwater Wind
New York/Rhode Island, US

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Figure 3

Sea-to-Shore Transition at Beach Lane, Aerial View

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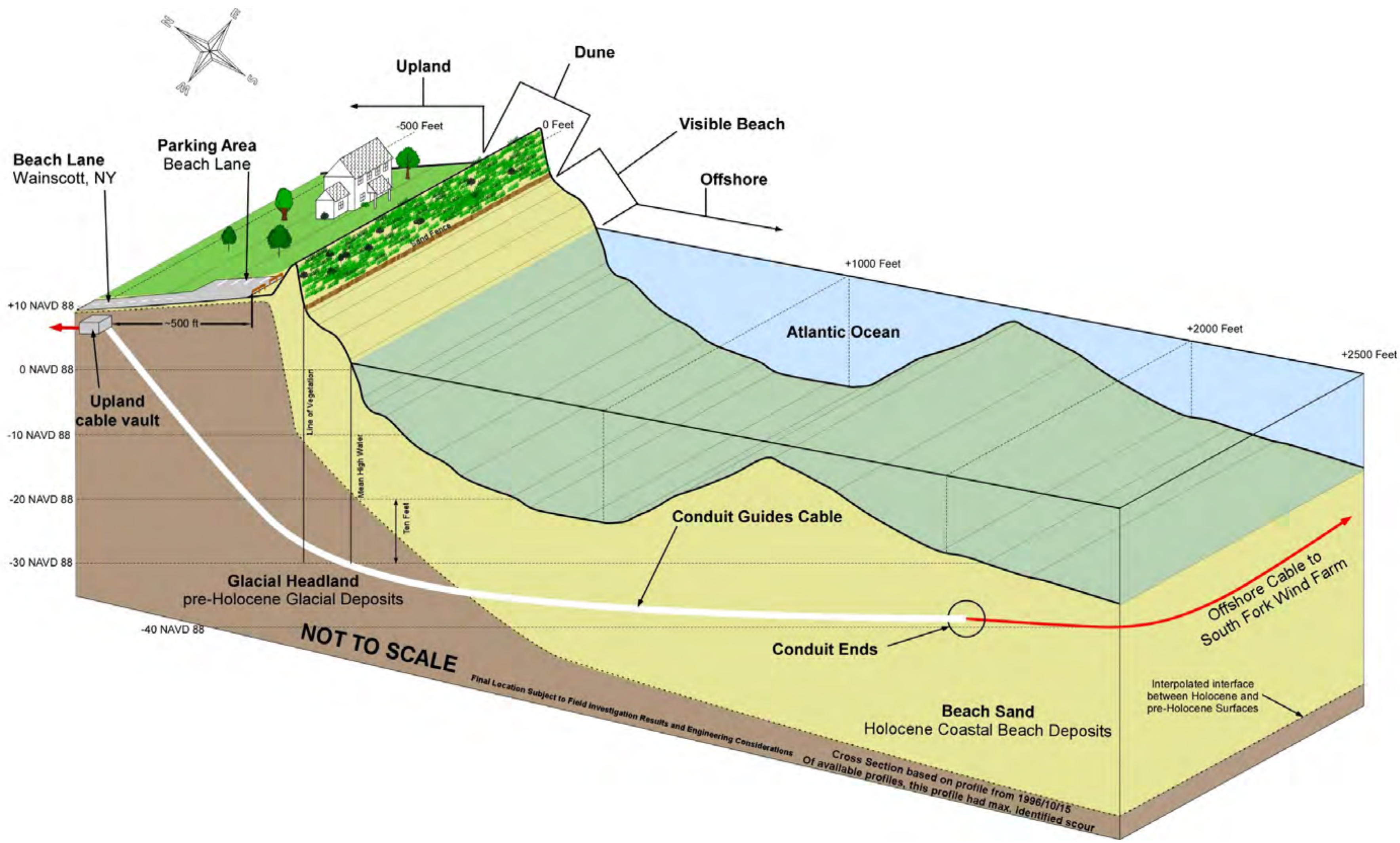
Figure 4



Sea-to-Shore Transition at Beach Lane, Conceptual Drawing

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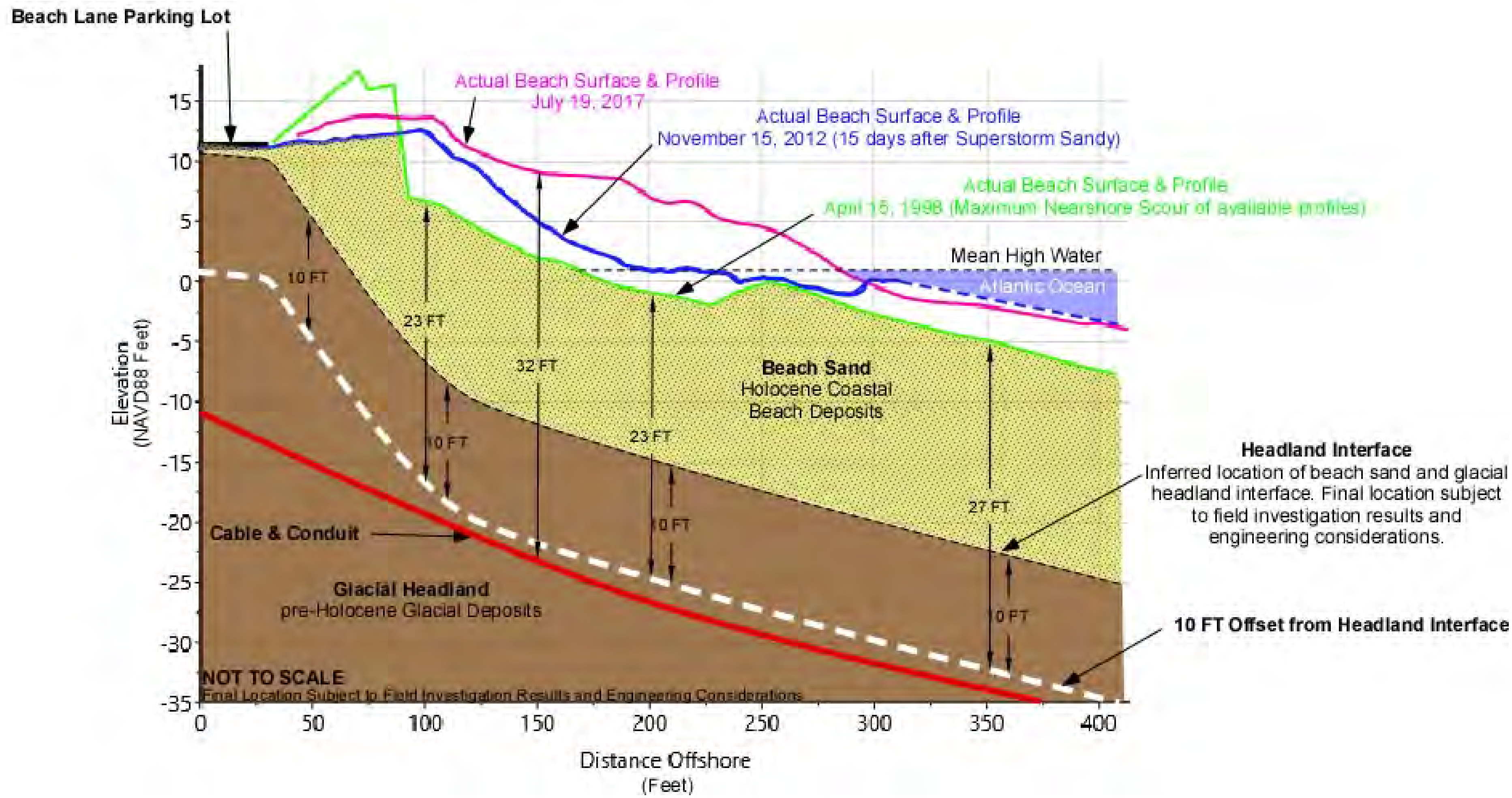
Figure 5



Sea-to-Shore Transition at Beach Lane, Cross-Section

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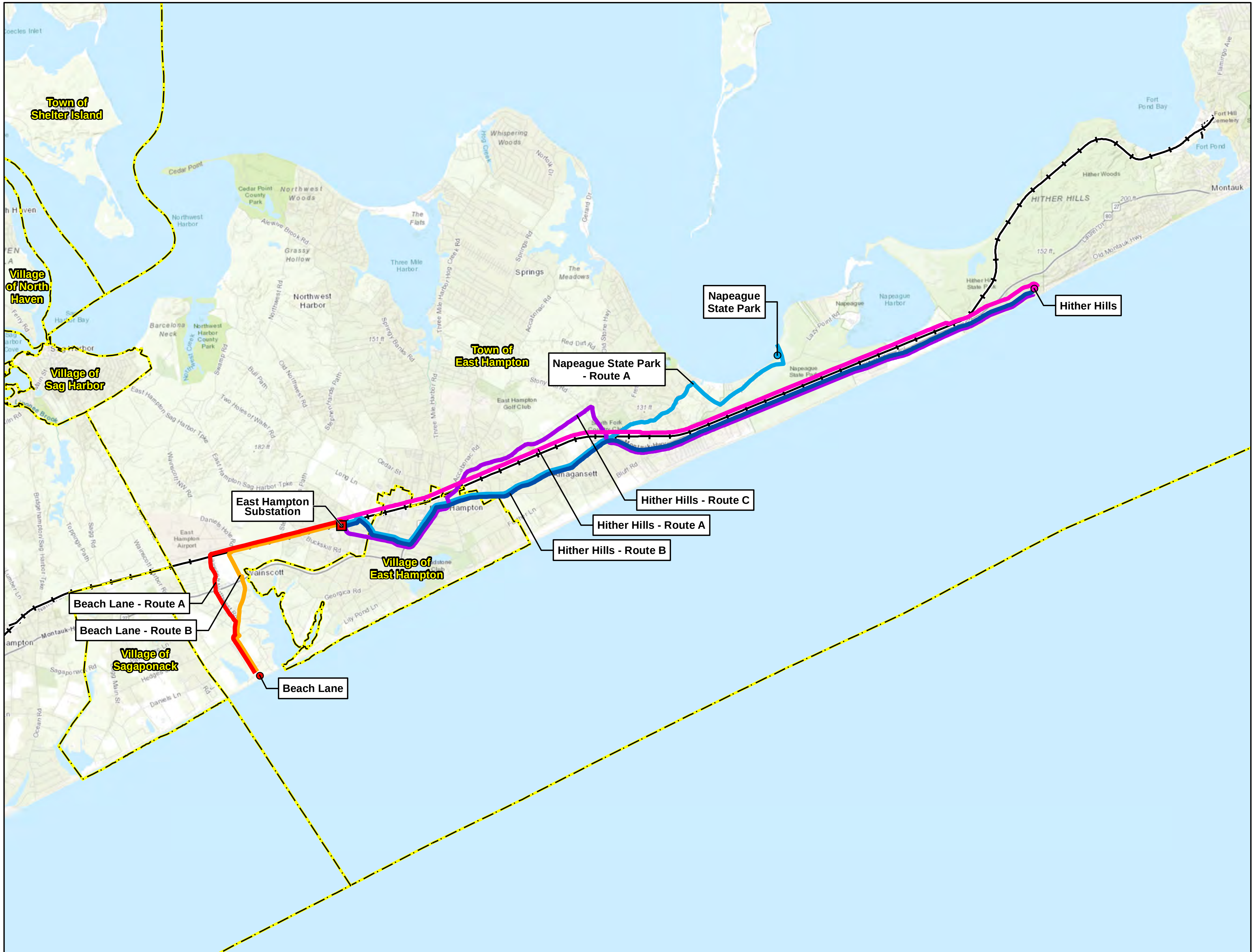

Locator Map

Legend

Substation:
- East Hampton Substation

Landing Sites:
- Beach Lane
- Hither Hills
- Napeague State Park

SFEC - Onshore Routes:
- Beach Lane - Route A
- Beach Lane - Route B
- Hither Hills - Route A
- Hither Hills - Route B
- Hither Hills - Route C
- Napeague State Park - Route A
- Railroad
- Municipal Boundary

Disclaimer:
Draft for discussion purposes. Data may change.

Sources:
1. ESRI World Topo; 2. Civil Boundaries, NYS ITS GIS Program Office, 2017

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SOUTH FORK WINDFARM

Land Cable Alternative Routes Overview
February 23, 2018
Deepwater Wind
New York/Rhode Island, US

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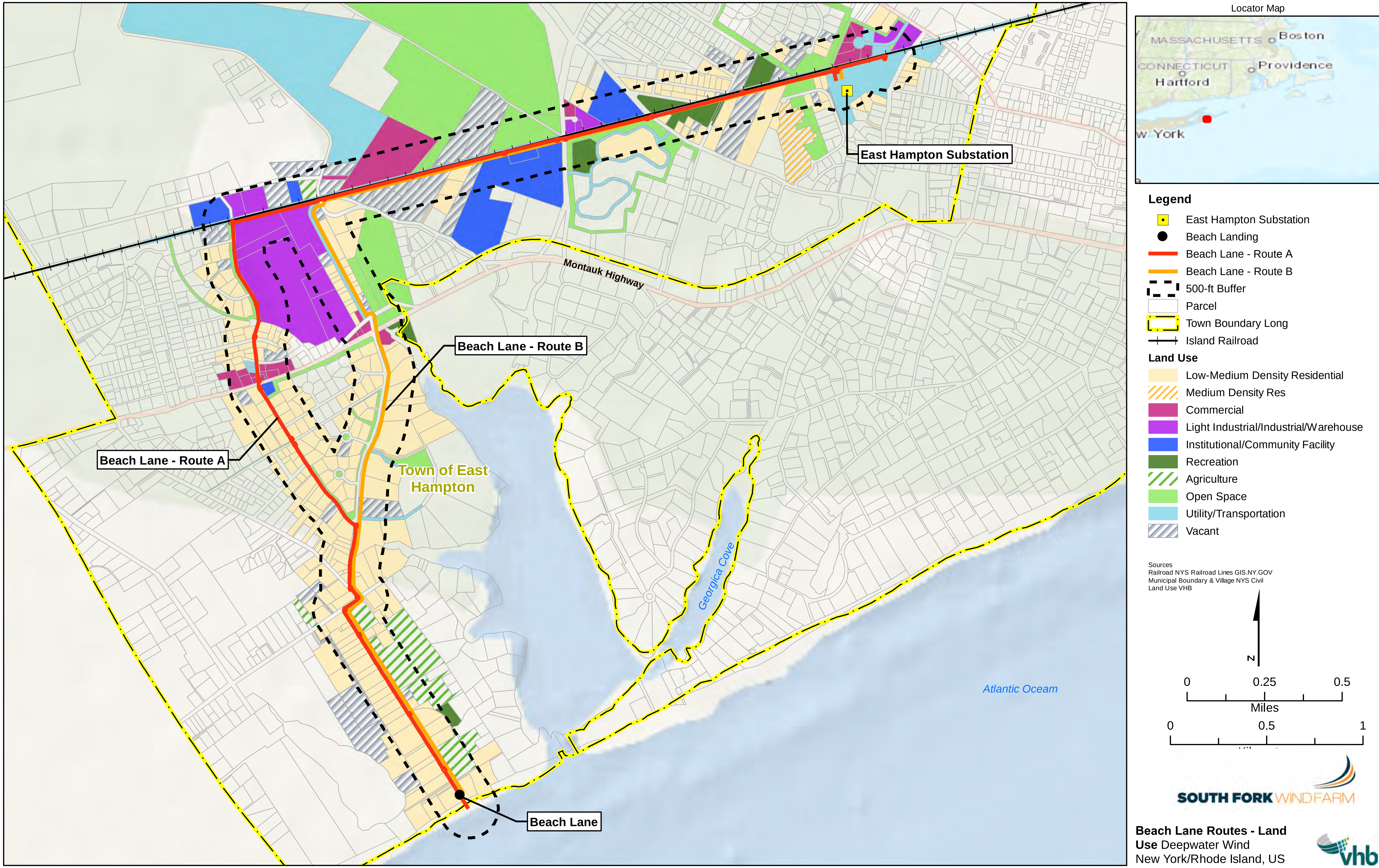

SOUTH FORK WINDFARM

Beach Lane Routes - Land Use Deepwater Wind
New York/Rhode Island, US

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Figure 8

Locator Map

Legend

- East Hampton Substation
- Beach Landing
- Beach Lane - Route A
- Beach Lane - Route B
- 500-ft Buffer
- Long Island Railroad
- Invasive Species
- Rare/Protected Species
- Invasive Species
- Delineated Freshwater Wetland Edge
- Delineated Tidal Wetland Edge
- Delineated Rare/Protected Species Habitat
- Delineated Wetland Resource
- NYSDEC Freshwater Wetlands
- Littoral Zone
- Coastal Shoals, Bars and Mudflats
- National Wetlands Inventory
- Parcel
- Town Boundary

Sources
Railroad NYS Railroad Lines GIS.NY.GOV
Municipal Boundary & Village NYS Civil
Land Use VHB

N

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Miles
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SOUTH FORK WINDFARM

Beach Lane Routes -
Wetland and Habitat Resources
Deepwater Wind
New York/Rhode Island, US

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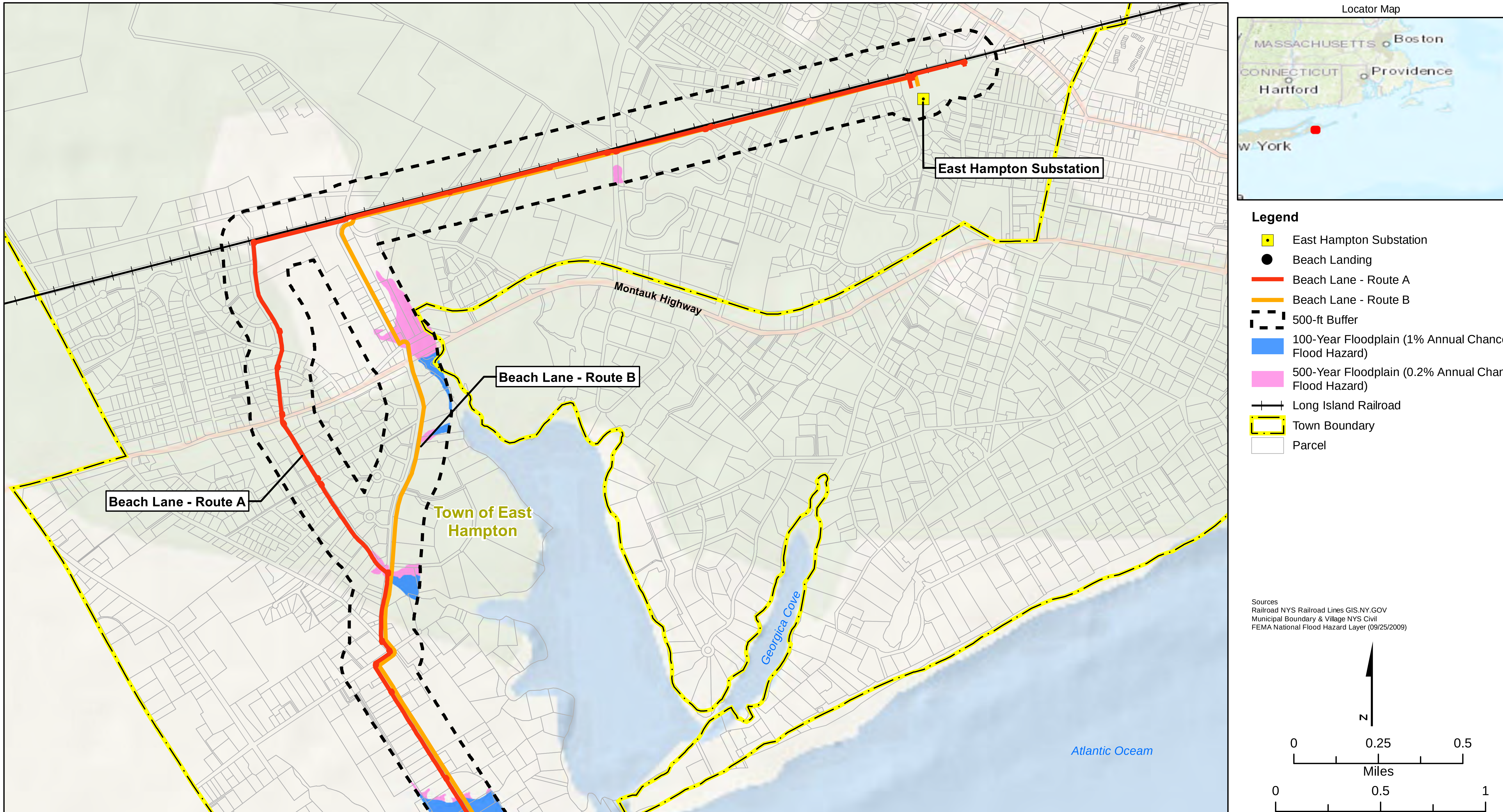
Figure 9



SOUTH FORK WINDFARM

Beach Lane - FEMA Floodplain
Deepwater Wind
New York/Rhode Island, US

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Appendix B PERMIT MATRIX

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SFWF and SFEC - Permits, Approvals, and Consultations			
Entity	**Permit, Approval, or Consultation**	**Statutory Basis, Regulations**	**Schedule**
FEDERAL			
Bureau of Ocean Energy Management (BOEM)	Site Assessment Plan (SAP) Approval	BOEM Regulations, 30 CFR 585.606, 610, 611	Approved, October 2017
BOEM	Construction and Operations Plan (COP)	BOEM Regulations, 30 CFR 585.626	COP submission: Q1 2018, approval Q1 2020
U.S. Army Corps of Engineers (USACE)	Section 10 Permit (or Nationwide Permit, if applicable)	Rivers and Harbors Act Section 10 33 USC. 333(e), 403	Same timeframe as COP
U.S. Army Corps of Engineers (USACE)	Section 404 Permit (or Nationwide Permit, if applicable)	Clean Water Act Section 404 33 USC 1344	Same timeframe as COP
National Marine Fisheries Service (NMFS)	As necessary for surveys and Construction Only: Letter of Authorization (LOA) or Incidental Harassment Authorization (IHA)	MMPA - 16 USC 1361 et seq 50 CFR 216	IHA to be obtained, as necessary, prior to surveys or construction
U.S. Coast Guard	Approval for Private Aids to Navigation	Coast Guard Regulation, 33 CFR 64.11	To be obtained pre-construction
U.S. Environmental Protection Agency (EPA) - Region 1	Outer Continental Shelf Air Permit - Prevention of Significant Deterioration (PSD) permit	Clean Air Act 42 USC 7627 40 CFR Part 55, 60	During COP review, expected to take 12 months
BOEM	National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS)	National Environmental Policy Act 42 USC 4321 et seq. Outer Continental Shelf Lands Act, 43 USC 1337 NEPA Regulations: 40 CFR 1500 et seq. BOEM Regulations: 30 CFR Part 585.628	During COP review, expected to take 12 months
U.S. Fish and Wildlife Service (USFWS)	Consultation under Section 7 of the Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), Bald and Golden Eagle Protection (BGEPA)	Federal ESA 16 USC 1531 et seq MBTA 16 USC 703 - 712 BGEPA 16 USC 668 - 668c 50 CFR Parts 10, 13, 17, 21, 22, 402 50 CFR Part10 50 CFR Part 22	During COP review, expected to take 12 months
National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS)	Consultation for Essential Fish Habitat	Magnuson-Stevens Fishery Conservation and Management Act 16 USC 1801 et seq 50 CFR Part 600	During COP review, expected to take 12 months
NMFS	Consultation under Section 7 of the ESA	Federal ESA 16 USC 1531 50 CFR Part 13, Part 17, Part 402	During COP review, expected to take 12 months
NMFS	Review and Consultation under Marine Mammal Protection Act (MMPA)	MMPA - 16 USC 1361 et seq 50 CFR 216	During COP review, expected to take 12 months
BOEM	Review and Consultation under Section 106 of the National Historic Preservation Act of 1966 (NHPA)	Section 106 of the National Historic Preservation Act of 1966 (NHPA)	During COP review, expected to take 12 months
National Park Service	Consultation and Determination under Abandoned Shipwreck Act	Abandoned Shipwreck Act, 43 USC 2101 - 2106	During COP review, expected to take 12 months
U.S. Coast Guard	Consultation with USCG regarding safety zones and communication plans for construction and waterway usage schedule	33 USC 1231 33 CFR Part 165	During COP review, expected to take 12 months
U.S. Department of Defense	Consultation with DOD regarding the proposed location of the offshore wind turbine and interconnection cable is required by BOEM during the NEPA review and in the Leases.	32 CFR Part 211, if applicable if informal review envisioned pursuant to 49 USC 44718 (Structures Interfering with Air Commerce or National Security)	During COP review, expected to take 12 months
Federal Aviation Administration	Determination of No Hazard to Air Navigation	14 CFR Part 77	Not applicable since WTGs are outside FAA jurisdiction

SFWF and SFEC - Permits, Approvals, and Consultations			
Entity	**Permit, Approval, or Consultation**	**Statutory Basis, Regulations**	**Schedule**
STATE			
NEW YORK			
Comptroller and AG	PPA Approval		Complete
Public Service Commission (PSC), Department of Public Service (DPS)	Certificate of Environmental Compatibility and Public Need (CECPN)	Article VII of the New York Public Service Law 16 NYCRR Parts 85 through 88	Similar timeframe as COP
PSC, DPS	Environmental Management and Construction Plan (EM&CP)	Article VII of the New York Public Service Law 16 NYCRR Parts 85 through 88	Similar timeframe as COP
PSC, DPS	Section 68 Petition (permission to exercise the grants of those municipal rights)	Article VII of the New York Public Service Law 16 NYCRR Section 68(1)	Similar timeframe as COP
New York State Department of Public Service Director of Energy Efficiency	Water Quality Certification	Section 401 of the Clean Water Act, Implementing Regulations 6 NYCRR Parts 701, 702, 704, 754 and Part 800 to 941	Similar timeframe as COP
PSC	Protection of Waters Permit, if required	Protection of Waters Program: Article 15, Environmental Conservation Law (ECL) – Implementing Regulations 6 NYCRR Part 608 and 621	Similar timeframe as COP
PSC	Tidal Wetlands, if required	Article 25, ECL – Implementing Regulations – 6 NYCRR Part 661	Similar timeframe as COP
Department of Environmental Conservation (NYSDEC)	State Pollutant Discharge Elimination System (SPDES) General Permit GP-0-15-002 for Stormwater Discharges from Construction Activity	Implementation of NPDES Program in NYS - 6 NYCRR Part 750-757	Prior to construction
NY Department of Transportation - Region 10 (NYSDOT)	Utility Work Permit - Form Perm 32	New York State Highway Law, Article 3, Section 52	Prior to construction
NYS Department of State (DOS) - Division of Coastal Resources	Coastal Zone Management Program (CZMP) Federal Consistency Certification	Coastal Zone Management Act (CZMA) 16 U.S.C 1451 et seq,15 CFR Part 930, 30 CFR 585.611(b), 627(b) State Article 42 of the Executive Law,19 NYCRR Part 600 and 6 NYCRR Part 617	Submitted in similar timeframe as COP, must be received before BOEM can issue approval
NYSDEC	Consultation and review of state-listed threatened and endangered species and unique or significant habitats	ECL Article 11, Section 535 NYSDEC - Natural Heritage Program 6 NYCRR Part 182	Similar timeframe as COP
Office of Parks, Recreation and Historic Preservation (NYS OPRHP) – State Office of Historic Preservation (SHPO)	Consultation and review of cultural and historic resources	Section 106 of the National Historic Preservation Act of 1966 (NHPA), and Section 14.09 of the New York State Historic Preservation Act of 1980 16 USC 470 6 NYCRR Part 617	Similar timeframe as COP
NY Department of Agriculture and Markets (NYS DAM)	Agricultural Data Statement	Article 25-AA of the Agriculture and Markets Law	Similar timeframe as COP
Rhode Island			
Rhode Island Coastal Resources Management Council	CZMP Federal Consistency Determination	CZMA 16 USC 1451 et seq, 15 CFR 930, 30 CFR 585.611(b), 627(b), Rhode Island Coastal Resources Management Program (RICRMP) Section 400	Submitted in similar timeframe as COP, must be received before BOEM can issue approval
Massachusetts			
Massachusetts Office of Coastal Zone Management	CZMP Federal Consistency Certification	CZMA, Section 307,15 CFR 923, 15 CFR 930, M.G.L. c.21A, § 4A, Consistency Review with the MCZM Program Policies 310 CMR 20.00 and 21.00	Submitted in similar timeframe as COP, must be received before BOEM can issue approval

SFWF and SFEC - Permits, Approvals, and Consultations			
Entity	**Permit, Approval, or Consultation**	**Statutory Basis, Regulations**	**Schedule**
COUNTY/LOCAL			
SUFFOLK COUNTY, NEW YORK			
Division of Planning	County Planning Referral	Section 239 of NYS General Municipal Law	Pre-empted by PSL §130
TOWN OF EAST HAMPTON, NEW YORK			
Highway Department	Road Opening Permit	Township of East Hampton Code Chapter 217, Article 1, Section 217-1	Pre-empted by PSL §130
Zoning Board of Appeals	Natural Resources Special Permit	Township of East Hampton Code Section 255-4-20b	Pre-empted by PSL §130
Waterfront Advisory Committee	Local Waterfront Revitalization Program (LWRP) Consistency Review	Town of East Hampton Code Chapter 149	Pre-empted by PSL §130
Building Department	Building Permit Below Gradework or Town Beach Parking Lot	Town of East Hampton Code Section 102-7	Pre-empted by PSL §130
Zoning	Article V - Special Use Permit Article VI - Site Plan Review Article VII - Architectural and Design Review	Town Code - Chapter 255 Zoning	Pre-empted by PSL §130
TOWN OF EAST HAMPTON FOR SUBSTATION			
Building Department	Building Permit	Town Code Section 102-7	Pre-empted by PSL §130
Planning Board	Site Plan Approval	Site Plan Chapter 255, Article VI (standards are in section 255-6-60)	Pre-empted by PSL §130
Planning Board	Special Permit, Public Utility	General Standards 255-5-40; Specific Standards 255-5-50	Pre-empted by PSL §130
Architectural Review Board	Approval	Town Code 255-7-30; 255-7-60	Pre-empted by PSL §130
Zoning Board of Appeals	Variances if Necessary, Natural Resources Special Permit if Necessary		Pre-empted by PSL §130
VILLAGE OF EAST HAMPTON - Applicable to Hither Hills Alternative Only			
Department of Code Enforcement	Site plan and special use permit for substation (for Hither Hills Alternative with LIRR)	Village of East Hampton Code Chapter 278	Pre-empted by PSL §130
Department of Public Works	Excavation Permit Application (for Hither Hills Alternative with LIRR)	Village of East Hampton Code Chapter 250	Pre-empted by PSL §130
NYS OPRHP (Parks)	Construction Permit (for Hither Hills)	Parks, Recreation and Historic Preservation Law §3.09	Similar timeframe as COP
NYSDEC	Coastal Erosion Management Permit (for Hither Hills)	Article 70 - 6 NYCRR Part 505 Coastal Erosion Management Regulations	Pre-empted by PSL §130

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Appendix C ASSESSMENT OF EMF AND HDD ON MIGRATORY MARINE FISH SPECIES

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Exponent®

MEMORANDUM

TO: Aileen Kenney, Deepwater Wind

FROM: Katherine Palmquist, Ph.D., William Bailey, Ph.D., Benjamin Cotts, Ph.D., P.E.

DATE: March 9, 2018

PROJECT: 1800738.EX0

SUBJECT: Assessment of the submarine South Fork Export Cable magnetic fields and HDD cable installation on key migratory marine species.

Summary

The electricity generated by the proposed offshore South Fork Wind Farm will be transported for use on land via the 138 kilovolt (kV) South Fork Export Cable (SFEC). Like all wiring, equipment, appliances, etc. connected to our electrical system, 60-Hertz (Hz) alternating current (AC) electric and magnetic fields (EMF) will surround the SFEC. EMF are of interest because of research showing that some marine species have specialized sensory receptors that are capable of detecting fields in the natural environment (e.g., the geomagnetic field and bioelectric fields from other fish in the frequency range from 0 to 10 Hz). However, research on these static and low frequency exposures is not applicable to the potential effects of exposure to the 50/60 Hz fields from submarine AC cables; hence, any assessment of potential effects on aquatic species must be based on research into the effects of 50/60 Hz AC fields. It should be noted that laboratory studies of the effects of such EMF on fish are not available for all species of interest, given the limitations of laboratory facilities, the difficulty of maintaining many species under artificial conditions, and the vast number of marine species. Nevertheless, the scientific literature does provide information on the sensory mechanisms underlying the ability of diverse species to detect fields which can be used to predict responses for each species group. As such, this literature provides a reliable basis for assessing likely responses to the SFEC magnetic field. Additionally, data from field surveys conducted at both submarine cable and offshore windfarm sites yield important information about how marine communities respond to

submarine AC cables under natural conditions. It should be noted that bottom-dwelling species are often specifically assessed, as they dwell in habitats containing the strongest EMF from such cables and are hence expected to exhibit the strongest responses. In contrast, pelagic fish including several types of schooling baitfish or prey species, which are not expected to dwell in close proximity to submarine cables, are far less likely to encounter the highest fields from the buried submarine cable. Considered together, laboratory and field data indicate the following:

- The magnetic field from the proposed SFEC submarine cable is below levels at which any critical effects on behavior on magnetosensitive fish are reported.
- The electric field induced by the 60-Hz magnetic field at maximum intensity in a large representative electrosensitive fish (a shortnose sturgeon) is well below reported detection thresholds.
- Field studies do not indicate changes in the distribution of natural fish communities or large invertebrates such as crustaceans or that their migration behavior is affected by the presence of 60-Hz AC cables.
- A specific assessment of the likelihood that striped bass and their prey (sandeel and herring) availability would be affected within the SFEC project area indicated that the density or distribution of these fish are not significantly changed at other wind farm sites.
- Multiple years of post-construction surveys conducted at existing wind farm sites indicate no significant effects on fish communities, in terms of species present and population abundances, beyond temporary effects associated with construction.

A summary of the different types of fishes and the anticipated effects of the EMF on those species are summarized in Table 1 (note that species in bold are known to be capable of detecting of induced electric fields).

Table 1. Summary of species in the Project area and the anticipated effect of EMF on their behavior

Assessed Species Groups	Magnetic Field	Induced Electric Field
Demersal bony Fish **American eel**, Black sea bass, Flounder complex (summer flounder, windowpane flounder, winter flounder, yellowtail flounder), Hake (red hake and silver hake), Scup, **Sturgeon (Atlantic and shortnose),** Striped bass	No adverse behavioral effects expected	Sturgeon model indicates no adverse effects for electrosensitive species
Elasmobranchs: (sharks, dogfish, skates): **Winter skate**	No adverse behavioral effects expected	
Invertebrates: American Lobster, Blue crab, Longfin squid , Shortfin squid	No adverse behavioral effects expected for crustaceans	

In addition Exponent reviewed the potential for horizontal directional drilling (HDD) at landfall to cause significant and/or lasting effects on key migratory marine species. In general, the underwater noise level produced by offshore drilling is far lower than other offshore activities including pile driving, dredging, and tidal/wave energy devices. The installation of the coffer dam may require limited pile driving. These noises have been associated with avoidance by some marine species, but recovery was noted as noise levels decreased. Given the nature of the HDD process, it is likely that noise levels will be even less than those associated with other types of drilling employed in the marine environment. Hence, adverse effects of migratory marine species are not anticipated from noises produced during HDD. Likewise, these species are not expected to be adversely affected by a release of drilling muds, as any such a release is unlikely during the HDD process. If release does occur, response and mitigation practices can limit the area of impact to the very immediate vicinity and use of natural clay drilling muds would limit effects to be equivalent to siltation events observed along the proposed cable route.

Background Information

The electricity generated by the proposed offshore South Fork Wind Farm will be transported for use on land on the 138 kilovolt (kV) South Fork Export Cable (SFEC). Like all wiring, equipment, appliances, etc. connected to our electrical system, the electric and magnetic fields (EMF) surrounding the cable will oscillate with a frequency of 60 Hz. The magnetic field is produce by the flow of electricity over the cable and is measured in units of milligauss (mG). The magnetic field is greatest at the surface of the cable and declines rapidly with distance. The voltage applied to the conductors within the cable is a source of an electric field but this electric field is totally shielded from the marine environment by grounded metallic sheaths and steel armoring around the cable. However, the 60-Hz magnetic field by its oscillating nature induces a weak electric field around the cable that, like the magnetic field, varies with the flow of electricity on the cable. This electric field is measured in units of millivolts/meter (mV/m). These fields around the SFEC are of interest because of research showing that some marine species have specialized sensory receptors that are capable of detecting fields in the natural environment. These fields include the static magnetic field of the earth with a frequency of 0 Hz, the near 0 Hz electric fields produced by ocean currents and fish movement in the earth's static magnetic field, and the electric fields produced by biological processes of fish with frequencies from 0 to about 10 Hz (Bedore and Kajiura, 2013).

Relevant Questions

Deepwater Wind requested that Exponent assess the potential effect of the 60-Hz EMF produced during operation of the SFEC on key marine migratory fish and invertebrate species that inhabit the vicinity of the project along the southeastern coast of Long Island. In addition, Exponent was asked to discuss the effect of horizontal directional drilling (HDD) during installation at the preferred cable landing site on key marine migratory fish and invertebrate species. Both exposure to EMF and noise/vibration from HDD have potential implications for migratory fish species.

This memo will address three questions:

1) Will the EMF from the operating cable alter the distributions of migratory fish populations in ways that adversely affect harvest or prey availability?
2) Is there any evidence that the EMF from the cable would alter prey availability for a key commercial fish species (striped bass)?
3) Is the HDD process likely to cause significant and/or lasting effects on key migratory marine species?

Question 1: Will the EMF from the operating cable alter the distributions of migratory fish populations in ways that adversely affect harvest or prey availability?

Given that a number of marine species are reported to use cues from the earth's static geomagnetic field with a frequency of 0 Hz to guide and direct migration (Hanson and Westerberg, 1987;

Walker et al., 1988; Tański et al., 2011), it is reasonable to ask whether the installation of the SFEC may interfere with their magnetic sensory systems, leading to altered distribution of migratory species, either by repelling individuals from the area or aggregating species along the cable route.

Marine Species of Interest. To answer this question, we reviewed and compiled available data from various sources including the National Oceanographic and Atmospheric Administration (NOAA) Essential Fish Habitat mapping tool[i], to identify important migratory fish, elasmobranch[1], and invertebrate species residing in the project area. Key life history information was determined for each identified species, including size, life stages expected to inhabit the site, environmental distribution (i.e., pelagic or demersal habitats) [Appendix A]. Species of commercial importance also were identified as were endangered and protected species. Once compiled, this information was used to focus on species of interest that are expected to encounter the cable route with the greatest frequency. For a majority of the more than 20,000 species of fish in the ocean, not much is known about their ability to detect electric and magnetic fields, as testing the sensitivity of every species individually is not feasible. However, the available research does provide a range of effects and response thresholds for a diverse group of fish, which is a reasonable basis for predicting the potential for those species found in the SFEC area to detect or react to the SFEC magnetic field. We focused on demersal (bottom-dwelling) fish, as these species are more likely to inhabit or transverse the seabed over the immediate cable route; these species are therefore the most likely to encounter the strongest magnetic fields produced by the cable. Based on data from the scientific literature, magnetic fields associated with submarine cables are strongest immediately adjacent to cables, decrease rapidly with distance, and are largely constrained to a few meters around the cable path; hence, demersal species are expected to be exposed to the strongest magnetic field intensities (Bull and Helix 2011, Love et al 2015). In contrast, pelagic and epi-pelagic[ii] fish would not be as likely to encounter the magnetic field associated with the operating submarine cable, as these species inhabit the upper parts of the water column, more distant from the elevated magnetic fields produced by the cables. Such pelagic species include anchovy, herring, menhaden, silversides, mackerel and tuna. Site-specific calculations indicate that the magnetic field from the SFEC,

[1] Elasmobranchs are cartilaginous fish like skates, sharks, and rays.

which is low, diminishes rapidly with distance (by more than 60% within 10 feet and by more than 90% within 20 feet; Exponent, 2018). Furthermore, at shallow water sites, the HDD cable installation much further below the seabed is expected to minimize such near-shore exposure due to the deep cable burial ranging from 6 feet to greater than 20 feet below the seabed. While pelagic species are expected to encounter the magnetic field produced by the SFEC cable, the attenuation of field strength with increasing distance from seabed means that the overlap between pelagic fish habitat and areas with significant magnetic fields will decrease as the water depth increases. Therefore, demersal species are expected to encounter the highest magnetic fields associated with the SFEC cable, and will experience such fields over a larger area than the pelagic species.

Another criterion used to assess the list of species of interest was evidence of migratory behaviors. Marine species migrate to spawning areas and feeding grounds, making migratory behavior an essential component of population viability; migration is guided by multiple cues, and in some species includes the perception of the earth's geomagnetic field. Hence, scientists have investigated whether the migratory species use of geomagnetic cues might be confounded by the magnetic field produced by submarine cables, which might result in disrupted migration and fragmented populations. Therefore, among demersal bony fish and elasmobranch species, we focused on those that demonstrate migratory behaviors. Demersal finfish, elasmobranchs (winter skate) and invertebrates (squid, crab and lobster) are all present and harvested in the vicinity of the SFEC site. We also included historically fished shortnose and Atlantic sturgeon, which are now protected under the Endangered Species Act.

Based on the available data and research, this selection process has produced the following list of the key migratory demersal species expected to encounter the export and HDD cable locations:

1) **Demersal bony fish:** American eel[iii], Black sea bass[iv], Flounder complex (summer flounder[v], windowpane flounder[vi], winter flounder[vii], yellowtail flounder[viii]), Hake (red hake[ix] and silver hake[x]), Scup[xi], Sturgeon (Atlantic and shortnose)[xii] Striped bass
2) **Elasmobranchs** (sharks, dogfish, skates): Winter skate
3) **Invertebrates:** American Lobster, Blue crab, Longfin squid[xiii], Shortfin squid[xiv]

In addition to the above species, pelagic bony fishes of commercial importance also are expected to inhabit the SFEC area; these include fish such as bay anchovy, menhaden, herring and shad. Any potential behavioral and population-level effects, if present, would be expected to be most evident in demersal fish species, which will be exposed to the strongest magnetic fields due to preference for sea bottom habitats.

Modeling of exposure to magnetic and electric fields. To evaluate the capability of such marine species to detect and respond to cable-generated magnetic fields and induced electric fields, Exponent calculated the 60-Hz magnetic field from the SFEC at maximum theoretical loading using parameters specified in the permitting design and conservative modeling assumptions.[2] The electric field induced in a shortnose sturgeon was calculated using methods applied in the BOEMRE (2011) report.[3] The results of these calculations are listed in Table 1.

Table 2. Calculated 60-Hz magnetic and induced electric fields (from shortnose sturgeon model) <u>at seabed</u> over buried SFEC 138-kV cable operating at maximum loading

Cable	Assumed Burial Depth (feet)	Magnetic Field (mG)	Induced Electric Field (mV/m)
HDD section of offshore export cable	>20	≤1.8	0.011
Offshore export cable	6	30	0.18

The magnetic field from a submarine cable is partially shielded by the outer metallic sheathing/armoring of the cable (BOEMRE, 2011). Measurements of the magnetic field around the similar export cable from the Block Island Wind Farm also buried to a depth of 6 feet were approximately 3 times lower than those calculated using similar methods. Hence, the calculated values of the magnetic and induced electric fields in Table 1 are very conservative and when installed the measured levels should be much lower.

The magnitude of the electric field (mV/m) in a large (40 inch) fish swimming on the seabed directly over the three cable segments has been calculated (Table 1); this size was selected to

2 Modeling was completed using a cable of assumed 8.5 inch diameter. The final cable diameter and internal dimensions may change as the design is completed.

3 There will also be small electric fields induced in the conductive seawater surrounding the cable but are not calculated here.

approximate a large, mature shortnose sturgeon. These calculated values provide an upper bound to the magnetic and electric fields from the SFEC as they do not account for any shielding of the magnetic field by the cable covering.[xv]

The magnetic field values in Table 1 were compared to data generated from laboratory and field studies in the published literature examining behavioral responses to magnetic fields associated with 60-Hz AC cables and evidence from field studies regarding the distribution and responses of marine communities to energized AC cables; a summary of findings is provided in the following sections. In addition, the calculated electric fields were compared to reported sensory capabilities of those species with specialized receptors that enable detection of electric fields emitted by other fish; the results are reported below.

SFEC magnetic field levels would not adversely affect fish and elasmobranchs

Geomagnetic field detection has been observed across a wide range of fish species, and is considered to be an important cue in guiding the migratory behavior of fish. A diverse number of fish, including tuna, herrings, carp, mackerel, and salmonids, contain small particles of magnetite in their skeletal system; these are thought to comprise part of the sensory system by which these fish detect the earth's static geomagnetic field (Hanson and Westerberg, 1987; Harrison et al., 2002; Walker et al., 1988; Öhman et al., 2007; Tański et al., 2011). Given that so many species have been demonstrated to contain magnetite, this indicates that geomagnetic detection is highly conserved across species and that multiple fish taxa can be expected to react similarly to magnetic fields. Thus, the sensory system of fish species, not the habitat, e.g., fresh or salt water, defines their capability to make use of, and react to, magnetic fields in the environment. For this reason, the reaction of different fish species to 60-Hz oscillating magnetic fields provides a basis to infer the reaction of other species that have not been explicitly addressed in laboratory or field studies.

The scientific research, which covers a wide range of fish species, does not indicate that 60-Hz fields have adverse effects on bony fish and elasmobranchs.[4] For example, a recent laboratory study conducted with largemouth bass and electrosensitive pallid sturgeon reported that under

[4] Fish with skeletons comprised of cartilage not bone.

realistic conditions, a magnetic field of approximately 6,000 mG generated by a 60-Hz AC power source had no reliable attractive or repellant influence on either fish (Bevelhimer et al., 2015).

As part of another study, these investigators reported that lake sturgeon, a known electrosensitive species, exhibited transitory signs of magnetic field detection when magnetic fields were turned on at 1,000 – 2,000 microtesla (µT, 10,000 – 20,000 mG) but stronger behavioral responses required exposure to magnetic field levels more than 1,000 times higher [165,780 µT (1,165,780 mG] (Bevelhimer et al., 2013). In a similar study, behavioral responses of lake sturgeon were confirmed at sudden exposures to magnetic fields between 3,510 and 165,780 µT (35,100 to 1,657,800 mG). However, paddlefish, an electrosensitive species related to sturgeon, exhibited no apparent altered behaviors under similar exposure conditions. A finfish species, redear sunfish, was also exposed to maximum magnetic field strengths of 124,000 µT (1,240,000 mG) with no significant behavioral changes (Cada et al., 2012). All these magnetic field strengths are many thousands of times higher than those expected at the SFEC site, and yet did not result in significant behavioral effects. Given these findings, we can conclude that magnetic fields produced at the SFEC would not result in adverse behaviors in any magnetosensitive fish present, as their sensitivities should be similar to other magnetosensitive species utilizing geomagnetic cues

An earlier laboratory study was performed with Atlantic salmon and American eel to determine if exposure to AC power sources operating at 60-75 Hz producing a 500 mG magnetic field would alter fish behaviors. The authors determined that neither species' behavior was altered by the presence of the AC magnetic field and concluded that these results provided ". . . no indication that proposed ELF [60-75 Hz] communications systems would influence the daily activity of Atlantic salmon or American eels." (Richardson et al.,1970). As with previous studies, the magnetic field strength tested was at least 10 times higher than those expected at the SFEC site.

A comprehensive field study has evaluated the effects of operating AC cables on resident marine communities. Although this study did not take place within the SFEC project area, it provides important data concerning the reactions of magnetosensitive fish and elasmobranchs to operating AC cables under realistic field conditions, and results can be used to make predictions about responses of other magnetosensitive species in New York under similar exposure conditions. Scientists at the University of California, Santa Barbara, conducted a multi-year study at a site containing both inactive and active (35 kV) unburied AC submarine cables (Love et al., 2016). The study was design to determine the effects of energized cables on the distribution of resident marine species, and the presence and abundance of fish species were recorded at sites along energized and de-energized cables, as well as at natural habitats located away from cable infrastructure.

Following the three-year investigation at the offshore sites, Love et al (2016) determined that increased numbers of several finfish species along cable routes were the result of the unburied cable itself, as it provided a vertical habitat, which likely acted as a Fish Attraction Device (FAD). Over 40 species were observed during the course of the study, including multiple rockfish species, perch, California halibut, sanddab, and seaperch. Researchers noted that fish were equally attracted to de-energized and energized AC cables (measured magnetic fields at the energized cable varied between 730 to 1100 mG). Therefore, it was concluded that the results provided no evidence that the presence of energized cables altered fish behavior and distribution.

Given the documented electrosensitivity and wide distribution of elasmobranch species, researchers have been particularly careful to note responses of these species to energized AC cables. Based on three years of scuba and submersible survey data, Love et al. (2016) determined that there was no evidence that *"energized power cables in this study were either attracting or repelling these fishes [Elasmobranchs]"* and therefore *"energized cables are either unimportant to these organisms [Elasmobranchs] or that at least other environmental factors take precedence"* (Love et al., 2016). Thus, magnetic fields between 730 and 1130 mG had no significant effects on the distribution of fish and elasmobranch species along a 60-Hz AC cable. The strength of these magnetic fields is 10 to 100 times higher than those estimated for the SFEC.

The scientific research reviewed does not support a conclusion that the installation of the proposed 60-Hz AC cable at the project site would adversely affect the localized distribution of key migratory fish species. The magnetic fields calculated directly above the buried SFEC, and along the export route, are 30 mG at the offshore export cable (Table 1), and especially low over the nearshore HDD section of the export cable (<1.8 mG) where fish are plentiful. These very weak magnetic fields are significantly lower than those determined to elicit behavior effects in laboratory settings (above 6,000 mG). Therefore, we would not expect cable-related effects on the density or distribution of either harvested fish species or their prey.

SFEC magnetically-induced electric fields are below detection thresholds of electrosensitive fish

Elasmobranchs (cartilaginous fish such as skates, sharks, and rays) and some fish species (e.g., sturgeon, reedfish, and lungfish) are able to detect weak static and very low frequency (0-20 Hz) electric fields via sensitive electroreceptor organs (*ampullae of Lorenzini)* on the snout and gills (Bouyoucos et al., 2013). To assess the likelihood that electrosensitive migratory species could detect and respond to induced electric fields, we calculated the expected electric field that would be induced in a 40-inch shortnose sturgeon[xvi] by the oscillating 60-Hz magnetic field (See Table 1).

The magnitude of the electric field induced within marine species depends on the size of the animal as well as its distance from the cables. The shortnose sturgeon was selected as a representative large fish due to its noted electrosensitivity, relatively large size, and high importance due to its endangered status: as such it represents a conservative model for determination of the area of effect. Other demersal species, that were investigated are either not electrosensitive, smaller, or both, and thus induced electric fields would be far less than, or non-existent, than that predicted for sturgeon.

Published sturgeon detection thresholds were used to evaluate potential electric field detection by electrosensitive fish and elasmobranchs along the cable route. The only demersal commercially fished elasmobranch identified by the previously outlined species selection process was the winter skate, which is smaller than the sturgeon model utilized (Sulikowski et al., 2003). Because the strength of the induced electric field increases with the size of the organism, the larger model will be conservative for smaller electrosensitive species. The calculated electric fields for the cable segments are presented for the target 6-foot burial depth (Table 2).

According to data from the published scientific literature, sturgeon respond to electric field intensities as low as 20 mV/m at a frequency 50-Hz (Basov 1999). As shown in Table 1, the maximum induced electric field in a very large fish is less than 0.2 mV/m, more than 100 times below the electric-field level expected to elicit behavioral responses in sturgeon. The strength of the electric field induced in smaller fish would be even weaker.

Given these results, we can conclude that, as designed, the project cables will not cause induced electric fields expected to be detectable by a large sturgeon, a highly electrosensitive demersal fish, and key migratory species inhabiting the project area. As this species comprises a conservative model based on its heightened sensitivity to electric fields and larger size, it is <u>not</u> expected that operating cables would result in behavioral responses in resident fish species due to detection of induced electric fields.

Available scientific literature does not suggest that large invertebrates are disturbed by 60-Hz AC cables

As with fish, several invertebrate species have demonstrated the ability to utilize geomagnetic cues in the guidance of orientation and migration (Cain et al., 2005; Boles and Lohmann, 2003). Given that commercially important magnetosensitive invertebrate species, including crab and lobster, inhabit the SFEC project area, their potential sensitivity to 60-Hz cables must also be assessed.

Love et al. (2015), discussed above, also conducted field studies of rock crabs caged over or near energized 60-Hz AC cables and un-energized cables off the coast of southern California. Magnetic fields measured in cages averaged between 462 mG and 800 mG adjacent to the energized cable, and decreased to below 9 mG at the far end of the cages; the magnetic-field level was less than 2 mG in cages surrounding the un-energized cable. These researchers found no significant effect of the magnetic fields on crab orientation within the boxes, and therefore concluded that the presence of energized AC cables did not elicit either significant positive or negative crab responses.

In another study, Love et al. (2017) investigated the potential impact of submarine cables on crab harvests via devices that allowed caged Dungeness and red rock crabs to select between traps located on the same or opposite side of a heavily-loaded AC cable (measured intensity between 138 and 1168 mG) off the coast of San Juan Island, Washington. The researchers determined that the fields from the cable had no effect on the catchability of crabs, and that these <u>unburied</u> cables did not act as a deterrent or barrier to crab movement (Love et al., 2017).

These findings have direct implications for the assessment of potential cable effects on the American lobster and blue crab. Like these species from the SFEC area, Dungeness and red rock crabs are large decapod crustaceans that undergo seasonal migrations (Fisher and Velasquez 2008; Carroll and Winn 1989). The field studies summarized above demonstrate that AC cables, even when unburied, do not present a barrier or deterrent to these species.

Little field evidence is available regarding the potential effect of AC submarine cables on the behavior and distribution of squid species. At least one study at an offshore windfarm site found no change in the number of squid at an offshore wind farm site in the North Sea (Rumes et al., 2013). Further, during the Love et al (2015) caged crab studies, researchers observed a loss of deployed crabs from cages, and theorized that this resulted from predation by octopuses. Since predation rates on crabs were similar along both the energized and un-energized cables, this suggested that if octopus were responsible, that the octopus distribution and behavior was not significantly affected by magnetic field generated by AC cables, indicating no adverse effects of AC cable EMF would be expected for cephalopods, including squid and octopus.

In conclusion, while comparatively little research has been conducted on the effects of AC cables on field populations and behaviors of commercially important invertebrate species, the available information indicates that (as with fish and elasmobranchs) the presence of an AC cable operating at a frequency of 60 Hz would not be expected to alter the behavior or distribution of large crustaceans. The maximum magnetic fields calculated for the SFEC site (Table 1) are significantly lower than the magnetic fields recorded during the caged crab studies 138 to 1168 mG; therefore, it can be concluded that buried cables will not constitute a barrier to crustacean migrations. Currently, there is only minimal data on cephalopod species, but these field data indicate that magnetic fields below 600 mG are unlikely to affect octopus predation behaviors and by extension squid predation and migratory behavior.

Long-term ecological surveys conducted at offshore wind farm sites do not indicate adverse effects to biological resources

The effect of offshore wind farms on populations of resident fish and invertebrates has been studied at a number of existing wind farm sites. Most of these have been assessed through a comprehensive survey approach[xvii], designed to detect changes in fishery resources in the general vicinity of offshore wind farms. Although such studies are not focused on determining the specific effects associated with AC transmission cables, they will detect any changes in fishery resources associated with the overall projects. Analysis of almost ten years of fish surveys conducted at the Horns Rev Offshore Wind Farm site near Denmark demonstrated "no general significant changes in the abundance or distribution patterns of pelagic and demersal fish," although turbine footings did result in the localized proliferation of hard ground species (Leonhard et al., 2011). Over 40 fish species were assessed as part of these surveys, including herring, cod, sole, mackerel, sandeel, and various flounder and flatfish. Studies conducted at the Thorntonbank Wind Farm site (Belgium) indicated some temporary increases and decreases in some fish and invertebrate species, but these were residual effects associated with construction (Vandendriessche et al., 2015). Overall, no large-scale persistent changes in populations were observed. Investigations into the effects of construction of the Nysted wind farm (Denmark) found no population level effects, but did note some "asymmetries in the catches" on either side of the cable route for a few species (Vattenfall and Skov-og, 2006). However, there was no evidence that the migration of these species was blocked and effects did not reliability correlate with the strength of cable EMF. It was also not possible to compare post-construction data to baseline data, and authors could not rule out that effects were the result of temporarily altered physical conditions of the seabed along the cable route (Vattenfall and Skov-og, 2006).

In conclusion, populations of marine species at offshore wind farm sites with submarine export cables operating a 50 Hz have not been reported to be adversely affected. A comprehensive review of the ecological impacts of Marine Renewable Energy (MRE) projects found that, "to date there has been no evidence to show that EMFs at the levels expected from MRE devices will cause an effect (whether negative or positive) on any species" (Copping et al., 2016). This supports information from literature regarding the responses of marine organism to 60-Hz AC cables, both in the field and in laboratory. The lack of effect of 50-Hz cables in these studies is particularly useful for the assessment of 60-Hz cables because marine species would be expected to be even less sensitive to 60-Hz fields because the frequency range to which their sensory systems have evolved is even higher than the sensory range of most marine species (0 to 10 Hz).

Question 2: Is there any evidence that the EMF from the cable would alter prey availability for a key commercial fish species (striped bass)?

Striped bass are key predatory fish in coastal ecosystems and an important commercial species. Hence, a case study assessment of the expected viability of striped bass and key prey species is expected to provide valuable information whether the SFEC would alter key predator-prey dynamics.

Although the sensitivity of striped bass to 50/60 Hz AC magnetic fields has not been assessed, studies conducted with a static magnetic field source do not suggest that this species of fish is highly magnetosensitive (Cada et al 2012) indicating that it is unlikely striped bass are capable of sensing 50/60 Hz AC magnetic fields. Furthermore, no effects of 50/60 Hz AC EMF have been observed on demersal predatory fish, such as striped bass, at either offshore wind farms or submarine 50/60 Hz AC cable sites (Love et al. 2016; Vandendriessche et al 2015; Leonhard et al 2011). Yet, there is concern that indirect effects caused by changes in prey availability from the presence of the operating SFEC cable could also reduce striped bass density in the project area. Hence, an assessment of the potential for effect on fish species (e.g., sandeel and herring) that constitute key prey for striped bass was conducted to determine if there is evidence that predator-prey dynamics can be altered by operating 50/60 Hz submarine cables. Field studies at offshore wind farm sites provide the best data to determine potential population-level effects on such species.

Sandeels (or sand lance) are benthic, sediment-dwelling nearshore fish that comprise an important prey source for a number of key commercial species, including Atlantic cod, hake, and flounder in addition to striped bass (Auster and Stewart 1986). Given their close contact with the sea bottom, this species is expected to more frequently encounter the strongest cable-associated EMF versus pelagic forage fish which reside in the upper water column. Hence, sandeel were specifically targeted in surveys conducted at a number of offshore wind farm sites. Early fishery surveys at the Horns Rev wind farm site (Denmark) indicated that "the density of sandeels increased by approx [*sic*] 300% from 2002 to 2004 within the wind farm area and decreased by 20% in the control area during the same period. . . Hence, it is unlikely that the wind farm has a negative effect on the sandeel" (Vattenfall and Skov-og, 2006). A seven-year review of the fisheries resources present at the Horns Rev site found that although the local sandeel populations were increased in the short term, there was no long term effect of the turbine and cable installation on these species (Leonhard et al 2011). Instead, researchers surmised that construction activity may have caused predatory fish to temporarily avoid the installation area, allowing for a short-term increase in sandeel populations, followed by a quick return to normal, expected abundance following the return of predatory species once construction was completed. Similarly, episodic changes in sandeel abundance were also observed at the Thorntonbank and Bligh bank wind farms (Belgium), but when compared against concurrent changes at control sites, these were deemed not significant (Vandendriessche et al 2015).

Atlantic herring are migratory, schooling fish that are frequently found in surface waters; as such, this species is expected to encounter the SFEC cable less frequently than sandeel. However, they constitute a key prey source and a viable population is likely important for the production of a number of commercially important predatory fish species. Given this, studies of operating wind farms have assessed effects on both Atlantic herring and a sub-species of Atlantic herring, the Baltic herring. Abundance of Atlantic herring significantly increased in spring surveys conducted at both the control and windfarm areas after the construction of the Horns Rev wind farm. These data indicate no adverse effects associated with turbine or cable installation, but may suggest that larger-scale processes are structuring the local population (Leonhard et al 2011). Similarly, surveys conducted at the Nysted wind farm indicated that Baltic herring abundances were not affected by the installation of the wind farm and submarine transmission cables; between 342 and 2,815 herrings were captured in surveys conducted before construction, while post-construction surveys collected between 2,180 and 4,459 herrings (Vattenfall and Skov-og, 2006). Although researchers reported that Baltic herring distribution around the immediate cable route appeared to indicate “asymmetries” in herring catches on different sides of the cable, these effects could not be correlated with power production by the wind farm (as EMF was not measured, power production was used as a proxy for magnetic field strength; Vattenfall and Skov-og, 2006). As such, researchers noted that these data could not reasonable support a link between cable EMF and any localized effects on herring distribution; furthermore, there were no apparent implications for herring abundance within the larger project area.

In conclusion, not only do available data from biological surveys at offshore wind farm site indicate no adverse effects to commercially important predatory fish but key benthic and pelagic forage fish abundances are similar unaffected by operating wind farm sites. It should be noted that some species apparently experience transitory effects resulting from construction activities. However, such impacts are temporary. While there was some indication that localized herring distribution in the vicinity of the Nysted cable route was impacted, this effect could not be linked to cable field strengths and overall populations of herring in the project area were not reduced. Hence, there is no evidence that wind farms and associated submarine cables alter predator-prey dynamics within the project area.

Question 3: Is the HDD process likely to cause significant and/or lasting effects on key migratory marine species?

Horizontal directional drilling is an installation process wherein an underground tubular hole is drilled beneath a waterway, shoreline, or other critical habitat, and then the cable is pulled through a conduit in the hole. In general, for offshore projects, the HDD terminates beyond the nearshore region, exiting onto seabed at around the 15m isobath (Polayge et al., 2010). Advanced technologies are used to ensure precision of angle, depth and exit point.

When nearshore areas adjacent to offshore energy projects comprise critical ecological or aesthetic habitat, full trenching of the cable route may not be ideal, due to lack of protection for these habitats. In these cases, HDD techniques are employed to protect the nearshore area (Polayge et al., 2010). The HDD approach was employed by the U.S. Navy to install shore-landing fiber optic cables at San Nicholas Island, CA, at sites containing habitat for three protected species—the snowy plover, Channel Island night lizard and California elephant seal (Black et al., 2004). Traditional installation methods were not feasible due to the potential injury to these populations and their habitat. HDD technology allowed routing of the cable underneath the beach and tidal zone areas, protecting critical shoreline habitat. The authors noted that the resident “colony of Elephant Seals resting on the sand directly above the drill path remain[ed] undisturbed by the drilling operation” (Black et al., 2004). For similar reasons, HDD was employed during the installation of the Champlain Hudson Power Express Transmission HVDC cable to protect sensitive wetland and shoreline habitat, as well as critical areas for the endangered Karner Blue butterfly (US DOE, 2014). HDD techniques also allowed for the preservation and protection of sensitive seagrass beds during the installation of water pipelines at Laguna Madre, Texas (McMullan et al., 2015).

Consequently, HDD methods are frequently utilized to protect critical habitat during the installation of cables or pipes. However, the HDD construction process will result in the generation of some noise and vibrations[xviii]; there is also some risk of inadvertent release of drilling mud at the exit points, but the effect would be similar to a short-term resuspension of seafloor sediments by a dredge. The drilling mud typically used in HDD is natural bentonite clay rather than the synthetic drilling muds used for offshore oil and gas drilling. Bentonite clays are not toxic to marine life nor do they introduce high organic content materials to the drilling site (Neff, 1981).

HDD will likely require construction of a temporary coffer dam offshore at the exit point to permit connection and pulling of the cable through the underground conduit onto shore. The coffer dam will either be constructed with sheet piles and excavated below the seafloor surface creating a work space for cable work or will be a gravity cell structure which will be placed on the sea floor using ballast weight. The coffer dam is temporary and will be removed after the cable installation is completed.

In general, the underwater noise level produced by offshore drilling is far lower than other offshore activities including pile driving, dredging, and tidal/wave energy devices (Gotz et al., 2009). The installation of the coffer dam may require limited pile driving. These noises have been associated with avoidance by some marine species, but recovery was noted as noise levels decreased (Malme et al., 1984). Given the nature of the HDD process, it is likely that noise levels will be even less than those associated with other types of drilling employed in the marine environment. Hence, adverse effects of migratory marine species are not anticipated from noises produced during HDD. Likewise, these species are not expected to be adversely affected by a release of drilling muds, as any such a release is unlikely during the HDD process. If release does occur, response and mitigation practices can limit the area of impact to the very immediate vicinity and use of natural clay drilling muds would limit effects to be equivalent to siltation events observed along the proposed cable route.

Conclusions

A variety of fish species have evolved the capability over eons to detect and respond to magnetic and electric fields at frequencies common in their environment, e.g., the geomagnetic field and bioelectric fields from other fish in the frequency range from 0 to 10 Hz. Research on these exposures is not applicable to the potential effects of exposure to the 50/60 Hz fields from submarine AC cables. However, the use of data on a variety of species, including the limited ability to detect and react to magnetic and electric fields with frequencies of 50/60 Hz that are above the range of typical sensory detection (0-10 Hz) indicate the following:

- The magnetic field from the proposed SFEC submarine cable is below levels at which any critical effects on behavior on magnetosensitive fish are reported.
- The electric field induced by the 60-Hz magnetic field at maximum intensity in a large representative electrosensitive fish is well below reported detection thresholds.
- Field studies do not indicate changes in the distribution of natural fish communities or large invertebrates such as crustaceans or that their migration behavior is affected by the presence of 60-Hz AC cables.
- A specific assessment of the likelihood that striped bass and their prey (sandeel and herring) availability would be affected within the SFEC project area indicated that the density or distribution of these fish are not significantly changed at other wind farm sites.
- Multiple years of post-construction surveys conducted at existing wind farm sites indicate no significant effects on fish communities, in terms of species present and population abundances, beyond temporary effects associated with construction.
- Any effects of the HDD installation process expected to arise from noise generation would occur only during the duration of elevated noise. The employment of such techniques is designed to preserve and protect ecologically and aesthetically valuable beach and shoreline habitat and represents best management practice. As such, the temporary effects of the generated noise on the distribution of some marine species are preferable to expected long-term effects of trenching through beach habitat.

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[i] https://www.habitat.noaa.gov/protection/efh/efhmapper/
[ii] Defined as species that reside in the middle of the water column (pelagic) or near the sea surface (epi-pelagic)
[iii] https://www nefsc noaa.gov/sos/spsyn/op/eel/
[iv] https://www nefsc.noaa.gov/sos/spsyn/og/seabass/
[v] https://www nefsc.noaa.gov/sos/spsyn/fldrs/summer/
[vi] https://www nefsc.noaa.gov/sos/spsyn/fldrs/window/
[vii] https://www.nefsc.noaa.gov/sos/spsyn/fldrs/winter/
[viii] https://www.nefsc noaa.gov/sos/spsyn/fldrs/yellotail/
[ix] https://www nefsc.noaa.gov/sos/spsyn/pg/redhake/#south
[x] https://www nefsc.noaa.gov/sos/spsyn/pg/silverhake/
[xi] https://www nefsc.noaa.gov/sos/spsyn/og/scup/
[xii] Note that these are endangered species and therefore not commercially harvested. However, sturgeon are demersal, migratory and has been determined to be highly electrosensitive, and thus has been included for consideration.
[xiii] https://www.nefsc noaa.gov/sos/spsyn/iv/lfsquid/
[xiv] https://www nefsc.noaa.gov/sos/spsyn/iv/sfsquid/
[xv] If there are locations where the cables are surface-laid and covered only by a mattress, the magnetic field levels above would be higher. However, the extent of these potential surface-laid areas would be limited, non-contiguous, and not affect migratory behavior.
[xvi] For Shortnose Sturgeon, www.fishbase.org reports a maximum recorded length of 143 cm (approximately 56 inches), with a common length of 50 cm (approximately 19.5 inches). Girth was determined using a standard length-girth-weight relationship for the related lake sturgeon (http://files.dnr.state mn.us/areas/fisheries/baudette/lksweight.pdf). Hence, a length of 40 inches with a girth of 14 inches was selected to model the induced electric field produced by a large, mature shortnose Sturgeon.
[xvii] Before-After-Control-Impact (BACI), which includes collection of population data before and after wind farm construction both at the wind farm site and at a control site.

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	Scientific Name	Species Grouping for Adult Life Stage	Resident or Transient (migratory)	Life Stages Present in Area
Fish				
Alewife	*Alosa pseudoharengus*	Pelagic	Migratory (Anadramous)	Juvenile/Adult
American eel	*Anguilla rostrata*	Demersal	Migratory (Catadramous)	Egg
				Larvae
				Juvenile/Adult
Atlantic bonito	*Sarda sarda*	Pelagic	Migratory (Coastal)	Juvenile/Adult
Atlantic herring	*Clupea harengus*	Pelagic	Migratory (Coastal)	Eggs
				Larvae
				Juvenile/Adult
Atlantic mackerel	*Scomber scombrus*	Pelagic	Migratory (Inshore-Offshore and Coastal)	Egg
				Larvae
				Juvenile/Adult
Atlantic menhaden	*Brevoortia tyrannus*	Pelagic	Migratory (Inshore-Offshore and Coastal)	Juvenile/Adult
Atlantic needlefish	*Strongylura marina*	Pelagic	Resident	Egg
				Larvae
				Juvenile/Adult
Atlantic silversides	*Menidia menidia*	Pelagic	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	Demersal	Migratory (Anadramous)	Juvenile/Adult
Bay anchovies	*Anchoa mitchilli*	Pelagic	Resident	Egg
				Larvae

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	Scientific Name	Species Grouping for Adult Life Stage	Resident or Transient (migratory)	Life Stages Present in Area
				Juvenile/Adult
Black sea bass	*Centropristis striata*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Blueback herring	*Alosa aestivalis*	Pelagic	Migratory (Anadramous)	Juvenile/Adult
Bluefish	*Pomatomus saltatrix*	Pelagic	Migratory (Coastal)	Egg
				Larvae
				Juvenile/Adult
False albacore	*Euthynnus alletteratus*	Pelagic	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Little skate	*Leucoraja erinacea*	Demersal	Resident	Larvae
				Juvenile/Adult
Monkfish	*Lophius americanus*	Demersal	Migratory (Inshore-Offshore and Coastal)	Egg
				Larvae
				Juvenile/Adult
Mullet	*Mugil cephalus*	Pelagic	Migratory (Coastal)	Egg
				Larvae
				Juvenile/Adult
Red hake	*Urophycis chuss*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Sand eel (sand lance)	*Ammodytes americanus*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	Scientific Name	Species Grouping for Adult Life Stage	Resident or Transient (migratory)	Life Stages Present in Area
				Juvenile/Adult
Sand tiger shark	*Carcharias taurus*	Demersal/ Pelagic	Migratory (Coastal)	Juvenile/Adult
Sandbar shark	*Carcharhinus plumbeus*	Demersal/ Pelagic	Migratory (Coastal)	Juvenile/Adult
Scup	*Stenotomus chrysops*	Demersal/ Pelagic	Migratory (Inshore-Offshore and Coastal)	Egg
				Larvae
				Juvenile/Adult
Sea lamprey	*Petromyzon marinus*	Parasitic	Migratory (Anadramous)	Egg
				Larvae
				Juvenile/Adult
Shad	*Alosa sapidissima*	Pelagic	Migratory (Anadramous)	Juvenile/Adult
Shortfin mako shark	*Isurus oxyrinchus*	Pelagic	Migratory (Coastal)	Juvenile/Adult
Shortnose sturgeon	*Acipenser brevirostrum*	Demersal	Migratory (Anadramous)	Juvenile/Adult
Skipjack tuna	*Katsuwonus pelamis*	Pelagic	Migratory (Coastal)	Juvenile/Adult
Smooth dogfish	*Mustelus canis*	Demersal	Resident	Juvenile/Adult
Spanish mackerel	*Scomberomorus maculatus*	Pelagic	Migratory (Coastal)	Egg
				Larvae
				Juvenile/Adult
Spiny dogfish	*Squalus acanthias*	Demersal	Resident	Juvenile/Adult
Striped bass	*Morone saxatilis*	Pelagic/ Demersal	Migratory (Anadramous)	Juvenile/Adult
Summer flounder	*Paralichthys dentatus*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	Scientific Name	Species Grouping for Adult Life Stage	Resident or Transient (migratory)	Life Stages Present in Area
				Juvenile/Adult
Tiger shark	*Galeocerdo cuvier*	Pelagic	Transient	Juvenile/Adult
Weakfish	*Cynoscion regalis*	Pelagic/ Demersal	Migratory (Coastal)	Egg
				Larvae
				Juvenile/Adult
White perch	*Morone americana*	Pelagic	Migratory (Semi-Anadramous)	Juvenile/Adult
White shark	*Carcharodon carcharias*	Pelagic	Transient	Juvenile/Adult
Whiting (silver hake)	*Merluccius bilinearies*	Semi-pelagic	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Windowpane flounder	*Scophthalmus aquosus*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Winter flounder	*Pseudopleuronectes americanus*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
Winter skate	*Leucoraja ocellata*	Demersal	Migratory (Inshore-Offshore)	Juvenile/Adult
Witch flounder	*Glyptocephalus cynoglossus*	Demersal	Resident	Egg
				Larvae
				Juvenile/Adult
Yellowfin tuna	*Thunnus albacares*	Pelagic	Migratory (Coastal)	Egg
				Larvae
				Juvenile/Adult

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	Scientific Name	Species Grouping for Adult Life Stage	Resident or Transient (migratory)	Life Stages Present in Area
Yellowtail flounder	*Pleuronectes ferruginea*	Demersal	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
		Invertebrates		
American lobster	*Homarus americanus*	Demersal, free-living	Migratory (Inshore-Offshore)	Egg
				Larvae
				Juvenile/Adult
American oyster	*Crassostrea virginica*	Attached - wide depth range	Resident	Egg
				Larvae
				Juvenile/Adult
Blue crab	*Calinectes sapidus*	Demersal, free-living	Migratory (Inshore-Offshore and Coastal)	Juvenile/Adult
Blue mussel	*Mytilus edulis*	Attached - wide depth range	Resident	Egg
				Larvae
				Juvenile/Adult
Longfin squid	*Loligo pealeii*	Wide depth range	Migratory (Inshore-Offshore and Coastal)	Egg
				Larvae
				Juvenile/Adult
Ocean quahog	*Artica islandica*	Bury in soft sediments	Resident	Egg
				Larvae
				Juvenile/Adult
Sea scallop	*Placopecten magellanicus*	Demersal	Resident	Egg
				Larvae
				Juvenile/Adult
Shortfin squid	*Illex illecebrosus*	Demersal, free-living	Migratory (Inshore-Offshore and Coastal)	Egg
				Larvae

Appendix A. Characteristics of fish species in the area of the South Fork Wind Farm.

Species	**Scientific Name**	**Species Grouping for Adult Life Stage**	**Resident or Transient (migratory)**	**Life Stages Present in Area**
				Juvenile/Adult
Surf clam	*Spisula solidissima*	Demersal	Resident	Juvenile/Adult

Appendix D COASTAL GEOLOGY REPORTS

Historical Beach Profile Analysis, Beach Lane

Coastal Storm Impact Analysis, Beach Lane

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Historical Beach Profile Analysis

Beach Lane, Wainscott, NY

Prepared For:
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Prepared By:
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PO Box 1212, 4 Arthur Street
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September 29, 2017

FIRST Coastal

Table of Contents

1. Executive Summary

First Coastal Consulting (FCC) has undertaken an analysis of the available beach profile data and storm/post-storm photographs within the Beach Lane, Wainscott, NY region, in order to assist Deepwater Wind (DW) in assessing the feasibility of the region as a landing site for infrastructure associated with the South Fork Wind Farm.

Of critical importance in this analysis is the interface of the sub surface headland soils (pre-Holocene glacial till or outwash) and the recently deposited beach/dune sands that overlie the headland soils. First Coastal's analysis reveals that the recent Holocene (post glacial or less than 12,000 years before present) sand deposits are a thin overlay or cover of the headland (glacial) soils. The shoreline changes during storms have periodically revealed the location of these headland soils on Beach Lane and in the nearshore surf zone.

Based on a combination of the beach profiles and the storm/post-storm photographs, the headland and beach/dune interface lies at the seaward edge of the pavement on Beach Lane in Wainscott. The headland soils at this location are resistant to coastal erosion because they are semi-consolidated till and/or glacial outwash soils.

Beach profiles collected from 1939 to 2017 indicate that the nearshore interface of the headland soils and recent sand deposits lies at or below the greatest depth of scour revealed in these profiles, which is approximately -23 feet (NAVD 88) and approximately 1,000 feet offshore. The total average envelope of horizontal profile change recorded over the 78-year study period is approximately 260 feet. The changes in the profile seaward of 2,500 feet are less than 100 feet horizontal and 5 feet vertical.

These values (when coupled with an appropriate factor of safety) can be used to help develop a reasonable burial depth for a submarine cable.

2. Location of Study Area

The location of the subject analysis is the southern terminus of Beach Lane, in the hamlet of Wainscott, Town of East Hampton, NY extend into the Atlantic Ocean. Beach Lane is fronted to the south by the Atlantic Ocean, and to the east and west by developed residential properties and some agricultural land.

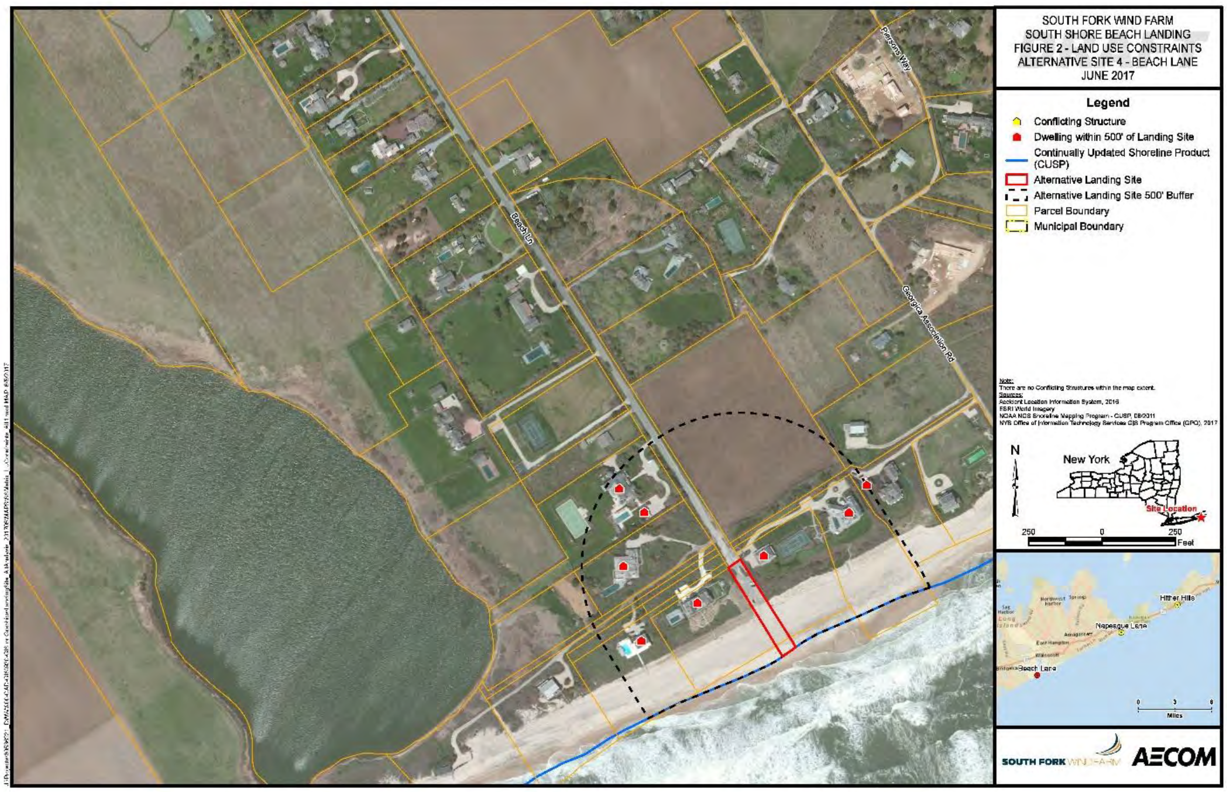

Figure 1: Location map for Beach Lane, Wainscott

3. Beach Profile Analysis

The profile data used for this analysis was obtained from three primary sources:

1) 1939-1956 from the U.S. Army Corps of Engineers,

2) 1995-2001 from the Atlantic Coast of New York Monitoring Program administered by New York Sea Grant, and

3) 2011-2017 from the Sagaponack BECD Beach Nourishment Project Monitoring.

The profile data was converted to a consistent geodetic format (NAD 83 for horizontal and NAVD 88 for the vertical) to facilitate analysis. The resultant beach profiles provide insight into the beach and dune changes as well as the nearshore hydrographic changes over a 78-year period.

Figure 2: General location of beach profiles compiled into a composite profile for analysis.

The composite beach profile contains several significant features as one moves from the land (left side) to the ocean (right side), most notably 1) the dune and beach, 2) a nearshore trough, 3) a nearshore bar, and 4) an offshore slope. The dune has diminished in height from over thirty feet in 1939 to less than 20 feet in 2017. Moving offshore (to the right), nearshore trough and bar system (located between -10 and -15 feet NAVD 88) fluctuated about 500 feet (between 1,000 to 1,500 feet offshore). This change is attributable to both long term recession as well as seasonal and storm induced changes. Seaward of the nearshore bar (from 1,500 feet to 5,000 feet) the profile is uniform in slope and variations reduced to +/- 2 feet at the 5,000-foot distance.

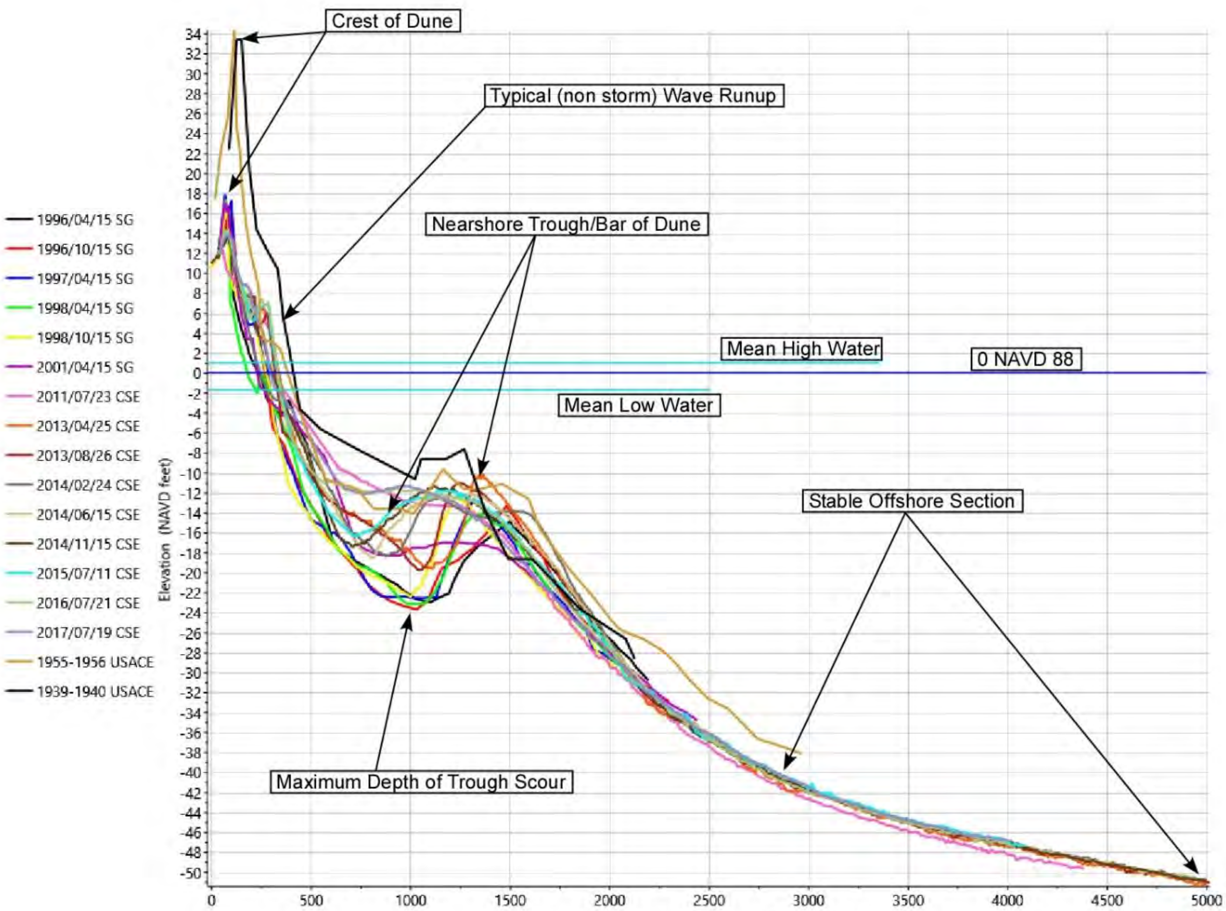

Figure 3: Composite beach profiles of the Beach Lane, Wainscott shoreline from 1939 to 2017. The land is to the left and the ocean is to the right. Elevations are in NAVD 88 and horizontal locations were rectified to NAD 83. For reference wave runup on the Wainscot beach is typically (non-storm) around +4 to +5 feet NAVD 88. The elevation of Beach Lane is approximately +9 to +10 NAVD 88.

The greatest depth of scour of the nearshore trough was observed to be approximately -23 feet (NAVD 88) at a location approximately 1,000 feet offshore. Seaward of the nearshore trough/bar system the, the changes in both horizontal and vertical dimensions reduce substantially. From -40 feet NAVD 88 at a distance of 2,500 feet from the shoreline out to the limit of the profile (-50 feet NAVD 88 at 5,000 feet offshore) the horizontal variation is less than 100 feet and the vertical variation is less than 5 feet.

It is unknown where this profile intersects the underlying headland soils that are either semi consolidated glacial tills or glacial outwash soils. However, the maximum scour depth of the nearshore trough and the relative stability of the profile seaward of the trough provide a reasonable baseline to establish a factor of safety for burial of a utility transmission cable.

The maximum envelope of horizontal change was calculated by averaging the overall change in profile from 1939 to 2017 at six different elevations in the vertical profile (see Table 1 below). This provided a maximum change over the 78-year period of study.

Elevation (NAVD 88)	Envelope of Change 1939 to 2017
10	266
5	260
0	233
-5	233
-10	333
-25	233
Average	260

Table 1: Total and average change in shoreline position from 1939 to 2017 taken at 6 vertical locations in the beach profile

Importantly, the horizontal change was both erosion and accretion, not solely erosion. In other words, the shoreline has an erosional trend, but experiences periods of recovery between each erosional event. However, the information in Table encompasses the maximum observed change over the 78-year study period.

4. Storm and Post Storm Photograph Analysis of Headlands

In addition to the beach profile analysis FCC investigated our extensive storm and post-storm photograph library to identify the extent and location of glacial headland soils in the upland and the nearshore. The location of this interface (called a "coastal facet") is important because it denotes a significant change in the resistance of soils to coastal erosion. The semi consolidated soils associated with glacial till and outwash is significantly more resistant to coastal erosion than unconsolidated sand.

Figure 4: Exposed pre-Holocene glacial headland located west of the study area. Note that the headland soils are significantly more resistant to wave erosion than the unconsolidated sand. The sands have been eroded away by the storm wave action. The headland soils are much less impacted.

Accordingly, this interface tends to provide an important boundary layer condition for important utility and infrastructure projects. Although headland soils are still subject to erosion, the rate of erosion is substantially less than unconsolidated sands (see for example, Dunes, Beaches and Peneplains on New York's Ocean Coast, Hanlu Huang, SoMAS Stony Brook, 2015)

Post storm photographs are an irreplaceable source of information because they are taken during or immediately after the storm strikes the shoreline. Storm and post-storm photographs often capture information that rapidly becomes covered as the beach recovers after a storm and before detailed beach profiles surveys can be mobilized.

First Coastal's storm/post-storm photographs reveal that the pre-Holocene (Glacial Outwash/Till) headland has been exposed several times in the last decades and is located at the seaward extend of the pavement on Beach Lane, Wainscott (see Figure 5 below). Note that the sand above the headland is eroded further landward than the headland (similar to Figure 4). Also note for scale the people climbing over the headland scarp, which is approximately three (3) feet above the storm beach and three (3) feet below the level of the road.

Also note the remnants of the asphalt roadway scattered on the beach and the overhang of the asphalt roadway. These observations provide excellent reference points to locate the headland today.

Figure 5: Post storm photographs taken on 2009-11-12 reveal the headland soils at the seaward end of Beach Lane in Wainscott.

Figure 6: An immediate post storm photograph of the beach east of the Beach Lane area taken after a coastal storm on 2008-12-22. The unconsolidated sand has been eroded off the top of the more resistant headland soils. Horizontal distance is over twenty feet in the foreground.

The photographs in Figures 4, 5 and 6 document that the pre-Holocene (glacial) outcroppings that underlie the more recent dune and beach sands are consistent along the beach at the Beach Lane project site and to the east and west.

These glacial soils represent the landward extent of any previous erosion and provide a clear and important boundary for determining where coastal erosion due to wave action is significantly limited because of the type and composition of the underlying soils.

5. Composite Beach Profile and Headland Soil Analysis

The beach profiles taken over a 78-year period and the storm and post-storm photographs together help define the parameters of pre-Holocene glacial soils boundary with the unconsolidated sands of the Holocene period that we commonly see as beach and dune deposits. In general, the combined beach and dune profile with the underlying Holocene/Pre-Holocene interface will look something like Figure 7 below.

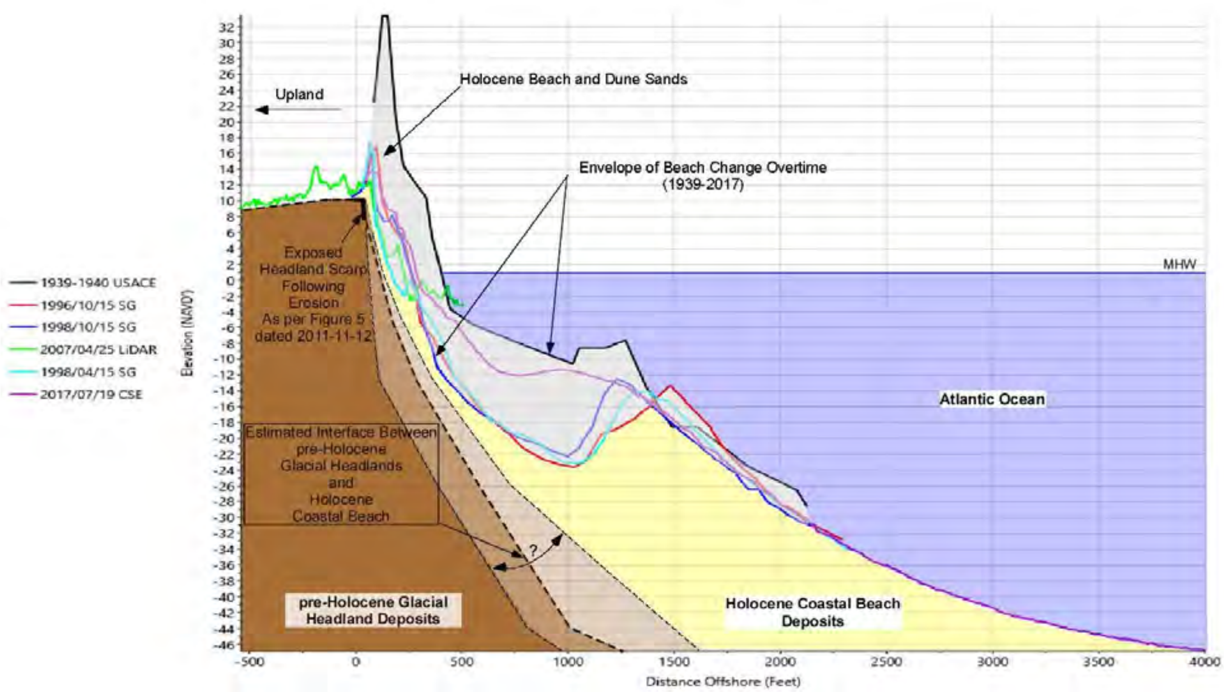

Figure 7: Illustration of the relationship between the observable beach and dune profile and the Holocene/pre-Holocene boundary that is only visible after coastal storm expose outcroppings.

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Coastal Storm Impact Analysis

Beach Lane, Wainscott, NY

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December 11, 2017

FIRST Coastal

Table of Contents

1. Executive Summary

During a meeting of the Environmental Subcommittee of the Wainscott Citizens Advisory Committee (WCAC) meeting held on November 13, 2017, FCC presented an Historical Beach Profile Analysis of the beach at the end of Beach Lane in Wainscott, NY. In response to the presentation committee members expressed a desire for FCC to provide further evaluation of impacts immediately following coastal storms in the area, specifically Superstorm Sandy and Nor'easters.

The committee provided two U.S. Geological Survey (USGS) reports on coastal storm impacts and requested that FCC evaluate the Beach Lane, Wainscott, NY region in the context of these two reports:

1. USGS, 2014, Hurricane Sandy: Observations and Analysis of Coastal Change
2. USGS, 2015, National Assessment of Nor'easter- Induced Coastal Erosion Hazards: Mid- and Northeast Atlantic Coast

These reports evaluated the shoreline with a model based on three different post storm shoreline conditions.

1. **Collision:** when the combination of storm surge and wave run-up erode the face of the dune but do not breach it.
2. **Overwash:** when the combination of storm surge and wave run-up overtop the dune in some but not all areas, leaving portions of the dune intact.
3. **Inundation:** when the combination of storm surge and wave run-up completely overtop the dune leaving little or no dune intact.

FCC findings are that in the area at and immediately adjacent to Beach Lane, Superstorm Sandy resulted in dune collision with minor dune impacts to the dune structure. Overwash occurred at Beach Lane due to low or no dune in the ~50-foot-wide road right of way. There was no inundation from Superstorm Sandy. Impacts from Nor'easters are modeled to be less than or similar to the specific results of Superstorm Sandy.

2. Location of Study Area

The location of the subject analysis is the southern terminus of Beach Lane, in the hamlet of Wainscott. Wainscott is located within the Town of East Hampton in Suffolk County, NY. Beach Lane is fronted to the south by the Atlantic Ocean, and to the east and west by developed residential properties and some agricultural land.

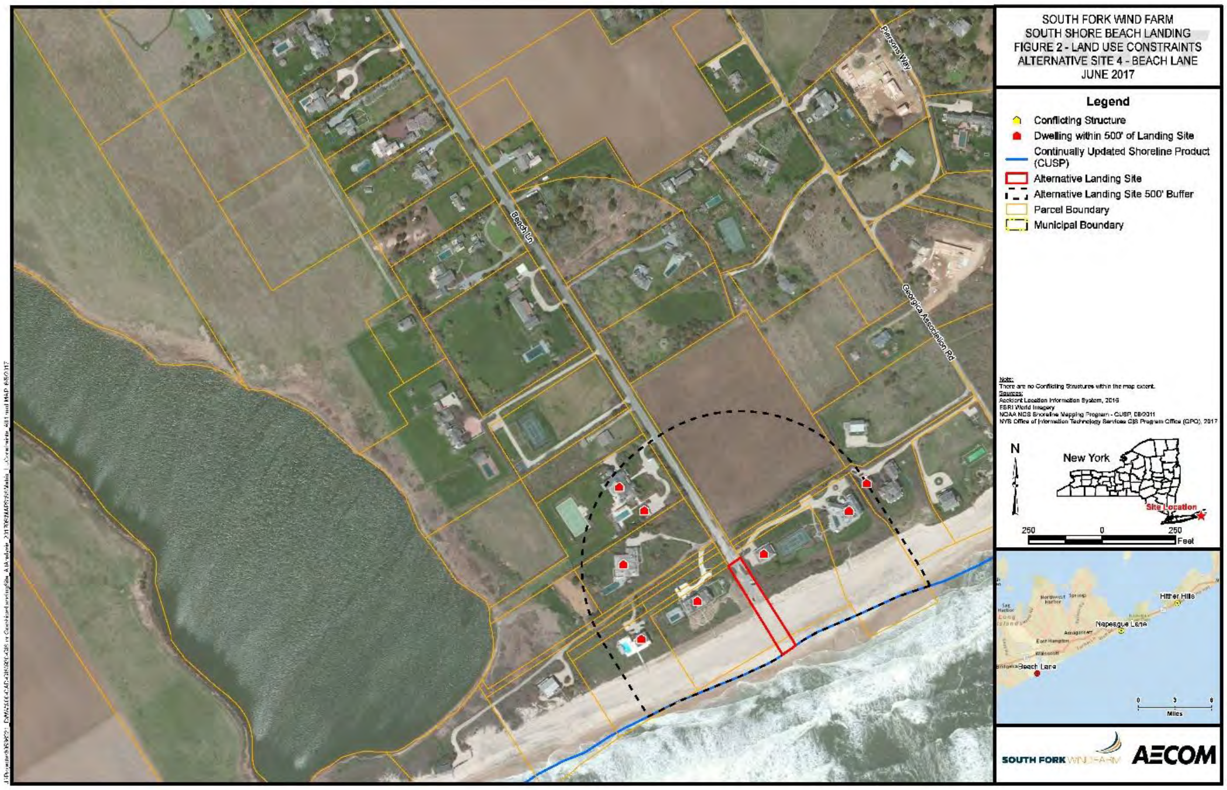

Figure 1: Location map for Beach Lane, Wainscott

FIRST Coastal

3. USGS- Hurricane Sandy Report: Evaluation

Evaluation of the *USGS, 2014, Hurricane Sandy: Observations and Analysis of Coastal Change* report and supporting USGS oblique photographs with reference to the Beach Lane, Wainscott, NY region has identified the following: In the immediate vicinity of Beach Lane there was some dune collision in the areas that had dunes adjacent to the Beach Lane access. The dunes east and west of Beach Lane remained more or less intact after Superstorm Sandy. This dune collision resulted in relatively minor losses to the dunes immediately adjacent to Beach Lane access when compared to the impacts Sandy had on other areas in the region. Surge from Superstorm Sandy did overwash directly at Beach Lane, where there was low or no dune fronting the area.

Superstorm Sandy impacted the Long Island area beginning on October 29th, 2012 extending until October 30th, 2012. The combination of high winds, waves, and tide surge pounded the coastline over three tidal cycles. The storm had sustained winds of 40 to 60 mph with gusts up to 90 mph. Waves and tides recorded during the storm exceeded all recorded storms in the last 20 years, including the 1992 northeast storm. The maximum wave height during Superstorm Sandy was approximately 32 feet at NOAA Buoy 44025 30 NM south of Islip, NY and the storm surge was approximately 5.6 feet above mean sea level at Montauk, NY. Superstorm Sandy was ranked as a 1 in 25-year storm in Montauk by the US Army Corps of Engineers. However, Sandy was a much more intense storm further west, registering up to a 1 in 200-year storm in New York City.

The large storm surge and wave heights that occurred with Superstorm Sandy led to inundation of the beach allowing for direct wave contact with the toe of the dune in the Beach Lane area. This wave impact resulted in dune collision characterized by loss to the toe of the dune. In the case of the immediate vicinity of Beach Lane, this dune collision resulted in loss to the toe of the dune but did not remove, overwash, or inundate the dune structure. This can be seen in Figure 2 a USGS oblique aerial photo taken on November 5, 2012 several days following Superstorm Sandy.

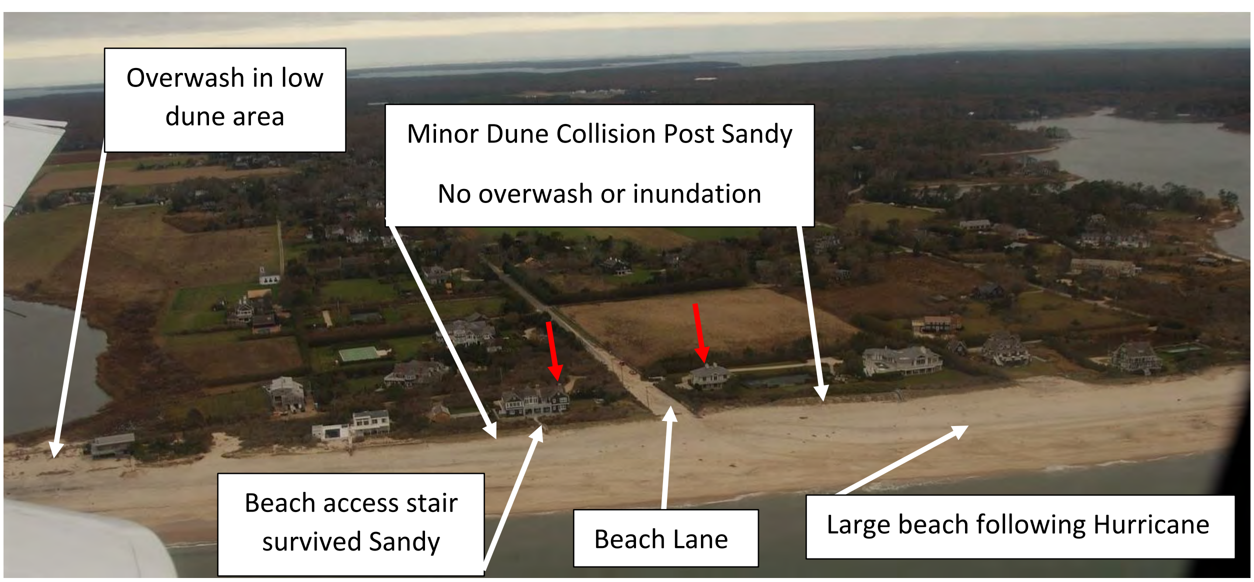

Figure 2: USGS aerial photo from November 5, 2012 post Superstorm Sandy.

In Figure 2 it can also be seen that the dunes immediately adjacent to Beach Lane did suffer some loss but the dune structure remained largely intact. Figure 2 also identifies a large wide beach following Superstorm Sandy. When the conditions of the post Superstorm Sandy beach identified in Figure 2 are compared to the USGS pre-Superstorm Sandy photos from the Beach Lane Region taken on May 20, 2009 (Figure 3) the relatively minor dune loss in the Beach Lane area can be seen in greater detail. The pre-Sandy dune was robust with the exception of the area fronting Beach Lane. These dunes resisted overwash and inundation during Sandy.

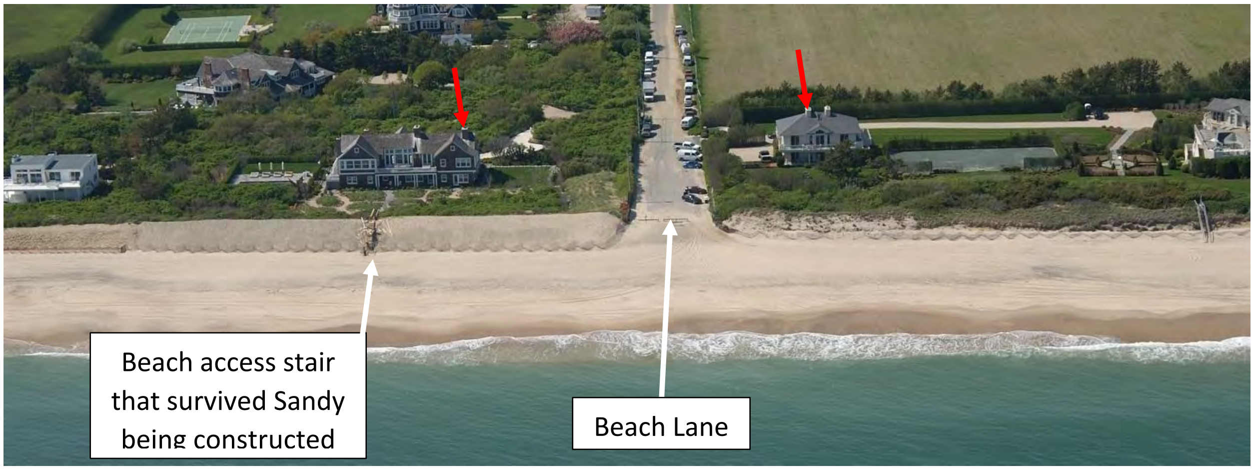

Figure 3: USGS aerial photo from May 20, 2009 pre Superstorm Sandy.

The small area at Beach Lane (~ 50 feet) was overwashed due to the low/no dune condition (Figure 4). During Superstorm Sandy there was some sand transported by the waves and storm surge approximately 300 ft. from the seaward end of the parking area north on to Beach Lane. This is a result of the lack of a dune or flood barrier at the seaward the terminus of Beach Lane. In this area elevation of the parking lot and Beach Lane is equal to the elevation of the backshore of the beach. Therefore, since there is no flood and erosion protection above beach level at the lot, and Beach Lane itself is very flat, the storm surge and waves from Sandy overwashed the beach and flowed directly into Beach Lane. Additionally, there was a dune overwash to the west of Beach Lane into Wainscott Pond. This was in an area that suffered from chronic erosion and had a low dune elevation prior to Sandy, which allowed for the overwash.

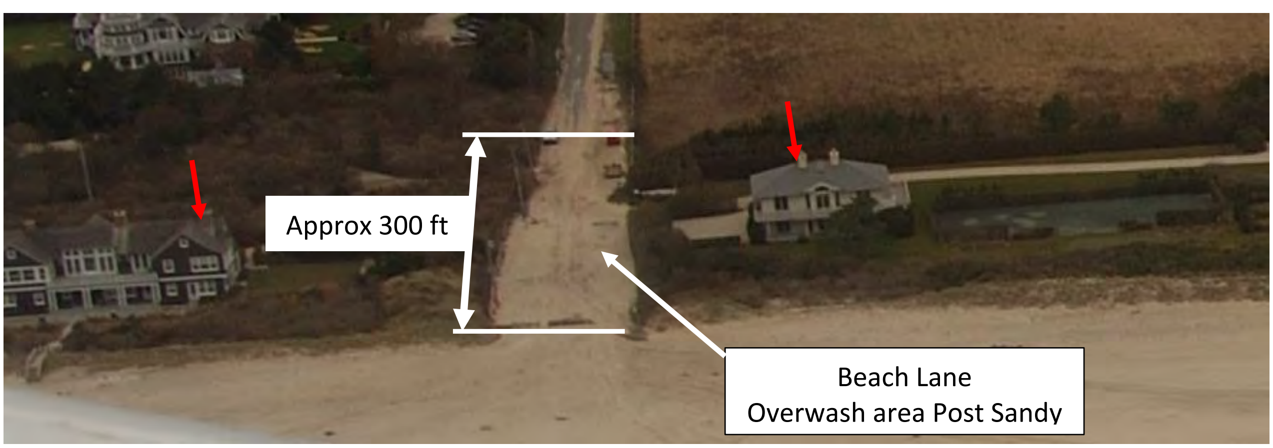

Figure 4: USGS aerial photo from November 5, 2012 post Sandy, close up of overwash.

4. USGS-Nor'easter Induced Coastal Erosion Hazard Report: Evaluation

The USGS report (*USGS, 2015, National Assessment of Nor'easter-Induced Coastal Erosion Hazards: Mid- and Northeast Atlantic Coast*) identifies the following three main responses to Nor'easter induced coastal erosion in a coastal setting:

Collision- wave action and storm surge inundate the beach and result in direct wave action at the toe of the dune that causes dune loss but the dune structure remains intact.

Overwash- wave action and storm surge inundate the beach and the dune and compromise the dune in an isolated region resulting in wave and sand transmission inland.

Inundation- wave action and storm surge completely inundate the region entirely, obliterating the dune resulting in massive regional flooding and sand transmission inland.

Comparison of the USGS storm classes (1, 2 & 3) and associated probability of collision, overwash, and inundation from Nor'easters are given in the Table below.

Description	Class 1	Class 2	Class 3	Sandy
Non- tidal Surge (m)*	.75	.90	1.38	1.7
Significant wave height (m)**	3.10	4.09	5.91	9.65
Dominant wave period (sec)**	14.81	14.81	13.79	14.81
^Probability of Collision %	42%	63%	81%	
^Probability of Overwash %	19%	33%	50%	
^Probability of Inundation %	4%	7%	12%	

*Montauk NOAA tide station 8510560

**Montauk NOAA Wave Buoy 44017

^Beach Lane, Wainscott, NY

The USGS model and application of that model to Beach Lane, Wainscott identifies that the likelihood of inundation in the Beach Lane area is relatively low even during large Nor'easter storms (4% to 12%). The threat of overwash was moderate (19% to 50%), and the likelihood of collision was high (42% to 81%).

These findings regarding Nor'easter storms agree well with the model results and actual field conditions observed during Superstorm Sandy.

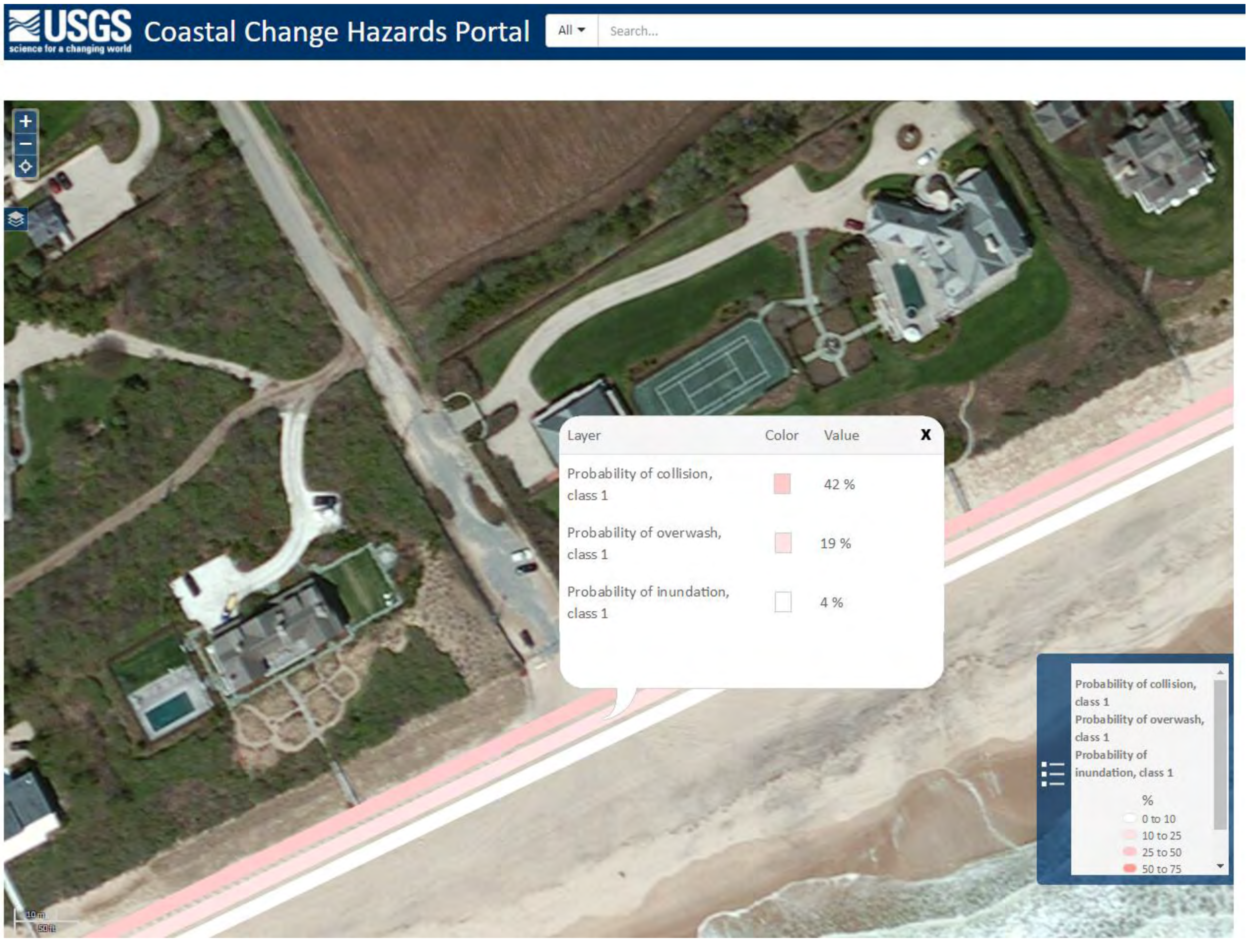

Figure 5: USGS Coastal Change Hazards Portal Class 1 percent probability of collision, overwash and inundation.

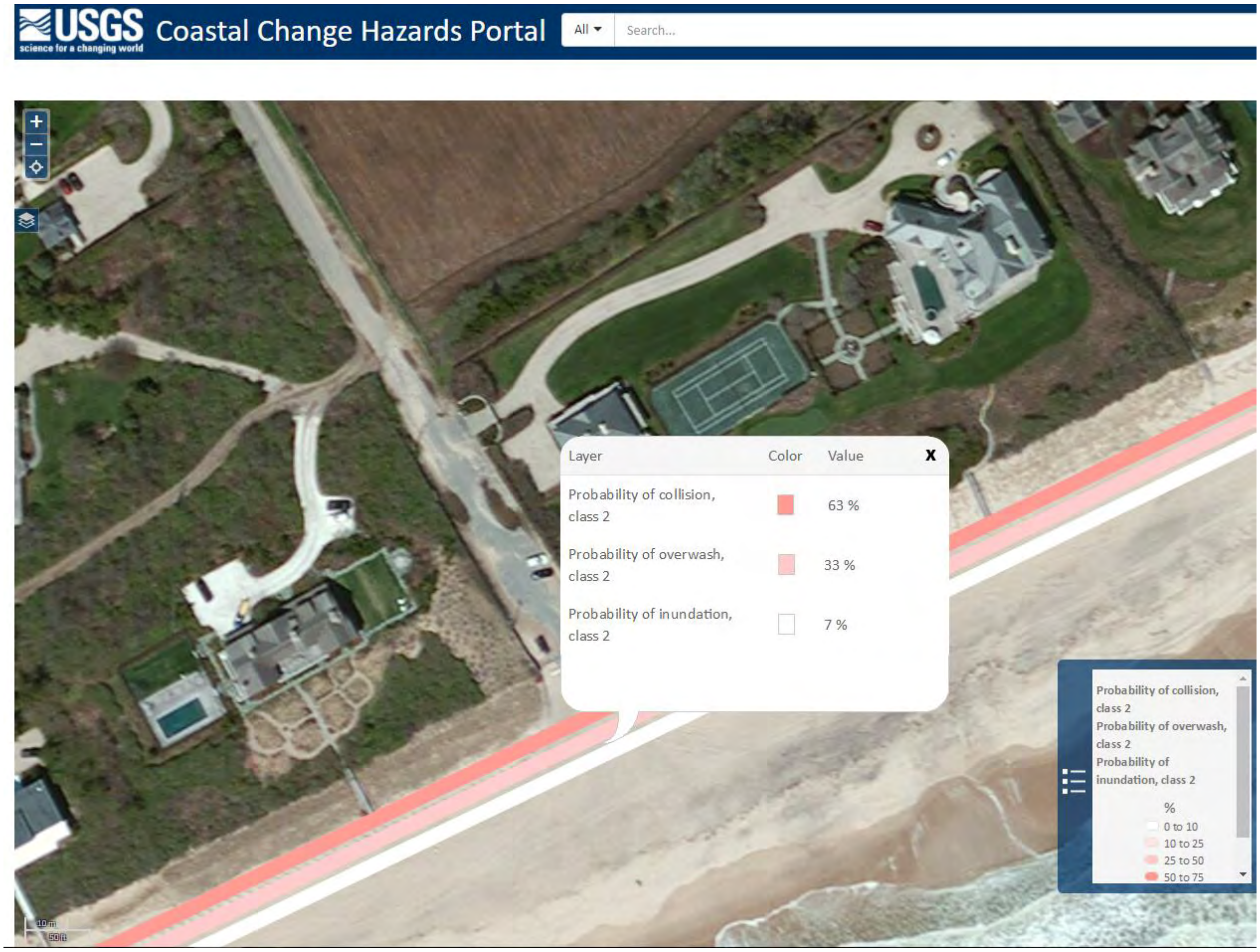

Figure 6: USGS Coastal Change Hazards Portal Class percent probability of collision, overwash and inundation.

Figure 7: USGS Coastal Change Hazards Portal Class 3 percent probability of collision, overwash and inundation.

5. Conclusion

FCC has undertaken an evaluation of the two above referenced USGS reports. These reports catalog shoreline impacts according to three potential conditions:

1. **Collision:** when the combination of storm surge and wave run-up erode the face of the dune but do not breach it.
2. **Overwash:** when the combination of storm surge and wave run-up overtop the dune in some but not all areas, leaving portions of the dune intact.
3. **Inundation:** when the combination of storm surge and wave run-up completely overtop the dune leaving little or no dune intact.

FCC findings are that in the area immediately adjacent to Beach Lane, Superstorm Sandy resulted in dune collision with minor impacts to the dune structure. Overwash occurred at Beach Lane due to low or no dune in the ~50-foot-wide road right of way. Impacts from Nor'easters are modeled to be less than or similar to the specific results of Superstorm Sandy.